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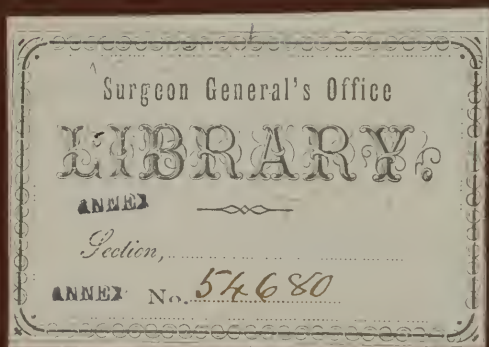
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AN OPERATIVE MANUAL.

LIGATION OF ARTERIES.

BY

DR. L. H. FARABEUF,

AIDE D'ANATOMIE À LA FACULTÉ, ANCIEN INTERNE DES HÔPITAUX DE PARIS.

TRANSLATED BY

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OF DARTMOUTH, N.H.

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TRANSLATOR'S PREFACE.

It has been because he thought he was doing some good for his profession, that the translator has devoted the little leisure at his command during the past autumn to putting into an English dress the excellent little *Manuel Opératoire* of M. Farabeuf,—“*Ligatures des Artères.*” Though the draper may not have done his work very elegantly, yet the identity of the “man” will be readily recognized beneath the habiliments “for a’ that.”

In Great Britain, and especially on the Continent, there is a continuous demand for such operative manuals, engendered by the laws of their medical educational curriculum, requiring a practical test of operative skill from every candidate for the doctorate.

Unfortunately for the profession and the public here in the United States, such requirement is not yet obligatory; and most young medical

men leave our colleges with no experience whatever in practical operative surgery. That we must "*first operate upon the dead, or mangle the living,*" seems, however, to be well known to a minority, who are found taking advantage of an extra, but non-compulsory, course now given at a few of our best medical schools, in connection with the regular fall and winter term, and who in the spring and summer attend the classes of some of the very excellent private teachers of operative surgery now to be found in a few of our cities.

It is for these, and for any country doctor who may be conscientiously striving to make up the deficiencies of his early pupilage, that we have done our work as a translator.

For the assistance of the operator we have appended the French scale of the centimetre and millimetre, and in contrast with it our English scale of inches and lines.



DANVILLE, KENTUCKY, December 12, 1873.

PREFACE.

WHEN I resolved to write an operative manual, I endeavored to form a clear conception of my object, and to fix definitely the form I should give my work.

My object was to supply the deficiencies which render our best treatises on operative surgery insufficient for the future practitioners who frequent the amphitheatre, to acquire that manual dexterity which is half of the surgeon.

This is not for the purpose of displacing any book; it can be easily seen how careful I have been to confine myself to my object.

Nothing could force me to write a complete manual of operative surgery. I am completely master of my programme, and have only responded to the solicitations of some of my very devoted old pupils; I have from the first eliminated special operations which I cannot competently describe, and will treat solely of the

current urgent operations (amputations, ligations, etc.) which every practitioner is called upon to perform, and which, contrary to what is the case regarding special operations, are not much dwelt upon in the books on general surgery.

It is this elementary surgery that the student ought to learn, as well for his examinations as for the exigencies of future practice.

He is, however, generally disappointed when, in the amphitheatre, knife in hand, he opens his classical works, and finds those chapters but abridged ones which are not devoted to the historical, anatomical, or chemical portion of surgery. He who at the time wishes only to learn how to operate, is not content with vague descriptions. He would fain seize the thread and run it straight out to the end.

He wishes that he should not only be told what to do and what to avoid, but *how* to do that which is to be done. I imagine that the authors who have been especially negligent on this latter point have been in doubt as to the efficiency of written teaching, and thought to leave it to the tutor whom pupils would be compelled to call to their aid in these practical lessons. They

have supposed this to be the province of custom or tradition, without thinking that tradition can be lost if not committed to paper.

It is because I am convinced that it is possible to bridge over this hiatus in a way to be useful, that I have attempted to do it. I shall, therefore, attempt to show *how* to operate, which is the capital point of all professional teaching.

I was unwilling to write first on amputations, not wishing to commence my task at the wrong end. Although it has been readily enough said, by the wiseacres of the medical world, that one can always get through an amputation, yet I think it is more difficult to amputate a limb *well* than it is to ligate an artery.

The difficulty of teaching a manœuvre is generally in proportion to the difficulty of its execution.

Another reason impelling me to commence with the ligation of the arteries, is, that these operations, which are frequently urgent, are somewhat of a terror to practitioners. One cannot improvise them; it is necessary to have learned the ligation of each artery methodically, like the manual at arms. It will not do to simply cut, as in an amputation; it is necessary to

find what we seek; and to find it surely, it behooves us to know the road, and to have gone over it many times.

I have, therefore, tried to compose a guide to the ligations which shall be clear and precise, and which, open to the eyes of the pupil before being engrafted on his memory as a practitioner, will enable him always to operate with success. That no one may mistake my intentions, I would again say that my only thought has been to aid practical teaching, and not to render it superfluous; for nothing can replace the assistance of the practical tutor, who operates before his pupils and has them to operate after him.

I have never forgotten for an instant that one should operate on the dead subject as if it were the living, foreseeing the same dangers, taking the same precautions, and supposing the parts involved by the knife to retain all the physiological peculiarities of the living, etc. This must be, if we wish the exercise of the amphitheatre to be a true preparation of the practitioner for the ligation of the arteries. For we would agree with Holmes in his *System of Surgery* (vol. iii. p. 464, 1st ed.), that putting a ligature on the living much resembles the same opera-

tion upon the cadaver. There are few contingencies to fear by an operator practiced upon the cadaver. But it is necessary to say practiced, for Holmes recalls the fact of Sir Philip Crampton, who, despite his great dexterity, before ligating the internal iliac repeated the operation seven times upon the cadaver, and learned something each time.

Whoever writes upon operative surgery finds that he has two rôles to fill. In the surgeon, in effect, there are two men: the clinician, who judges of the indications, the opportunity for an operation, etc., and the operator, who executes it. I would at once excuse myself from the clinical view; I might have been able to compile, but, to rest at peace with my conscience, I prefer referring to the books of experienced surgeons who have written on the subject, and to the treatises on external pathology, which are sufficient for this purpose.

Finally, I have not described all the known processes for ligating the arteries; I have guarded against this, and have preferred those which have been preferred before me by the most eminent surgeons of our epoch.

The reader will doubtless recognize that while

I have profited by the writings of my predecessors, I have not copied them servilely, but have left a trace of personality at many points. If he desires to learn to operate otherwise than as a mere amateur,¹ and if he puts my recommendations to practice, I am sure that he will appreciate the efforts I have made to guide his hand. At least, this is the sole recompense I expect to draw from this work.

Doubtless some will, at first glance, wonder at the novel form of this work. Experience in teaching has, however, demonstrated to me that there is nothing easy to the beginner; if there is any one inclined to reproach me with over-fastidiousness, it will be the already expert operator, and I would justify myself with him by referring him back to his first trials at operating.

My descriptions are printed in large characters. I have tried to make them short, rapid, and continuous, so that the pupil may take in the operation at a glance. I have also preceded and followed them with notes, in small text, on

¹ The most simple of the mechanical arts exact a long apprenticeship (La Bruyère).

the anatomy of the parts and certain operative precautions and manœuvres. After recalling to the mind of the pupil that anatomical knowledge which is indispensable, I command him, so to express it, to practice, indicating to him carefully and successively all the manœuvres which he should execute to accomplish his object; and, the road being now open to him, I give him all the necessary explanations for taking in and retaining what is useful in all the phases of the operation, so that he may not be compelled to operate mechanically.

I am obliged to take the sole responsibility of the designs which figure in the book, since they are of my own execution;¹ it may, however, be permitted me to say that the engraving has not always bettered them. Three insignificant figures I have borrowed. The best of the others are destined for the *Précis d'Anatomie*, which I am preparing with M. Hénocque.

However imperfect may be the illustrative portion of this little book, I have preferred to

¹ About half are from photographs obtained with the apparatus of Dr. Schaeb, to whose kindness I am much indebted.

make it as it is, representing the principal manœuvres indicated in the text, rather than to imitate those authors who confine themselves to figuring the result of the operation. What is to be thought, indeed, of those engravings which, across a cut in the skin of a limb which has no model, show the artery charged by the director? Do they not recall to mind the juggler suddenly exhibiting the ball? We see it very well; but where does it come from, and how does it come? If we try to repeat the trick, we shall be very much embarrassed.

BIBLIOGRAPHY.

BEFORE writing this work I reviewed our national authorities, together with the most noted foreign works, in which, however, I found nothing markedly different from what has been written among us.

I then read, or re-read, the description of the ligation of arteries in the *Traité de la Ligation des Artères* of M. Manec, and in the works on *operative surgery* of Sabatier and Dupuytren (edition of Sanson & Bégin), Velpeau, Lisfranc, Malle, Malgaigne, Sédillot, Chassaignac, Cl. Bernard and Huette, Guérin, Dubreuil, . . . and Marcellin Duval, where I have found excellent precepts.

I also read with profit Roux (*Quarante Années de Pratique chirurgicale*), Hodgson (*Maladies des Artères et des Veines*, translation of Breschet), and especially Samuel Cooper (*Dictionnaire de Chirurgie pratique*, in French, articles ANÉVRYSME

and ARTÈRES), to say nothing of our classical works on surgical pathology which have been published or are in course of publication.

Since the torsion of arteries has become the order of the day, the curious will find the bibliography of it in the Memoir of John D. Hill (*The Lancet*, Nov. 5th, 1870), and an analysis in *Archives gén. de Médecine*, 1871, tome ii. p. 349.

The pupil who wishes to own a little library on operative surgery, and especially on ligations, may buy the *Précis de Médecine opératoire* of Lisfranc, the *Manuel de Médecine opératoire* of Malgaigne, the *Traité clinique et pratique des Opérations chirurgicales* of M. Chassaignac, the *Traité de l'Hémostasie* of Marcellin Duval, and read the thesis of the lamented Cocteau on *Altérations des Artères à la Suite de la Ligature* (Paris, 1867).

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LIGATION OF ARTERIES.

PART FIRST.

GENERALITIES.

CHAPTER I.

DESCRIPTION OF THE LIGATION OF AN ARTERY.

THIS operation comprises three steps, which follow successively: I. the *discovery* of the sheath of the artery; II. the *isolation* of the vessel; and III. the *ligation* proper.

ARTICLE I.

DISCOVERY OF THE SHEATH.

It would be presumption to undertake to expose an artery while ignorant of the topography of the region into which one is going to carry his bistoury. The young men of France who wish to study surgical anatomy need not be embarrassed relative to written or theoretical teach-

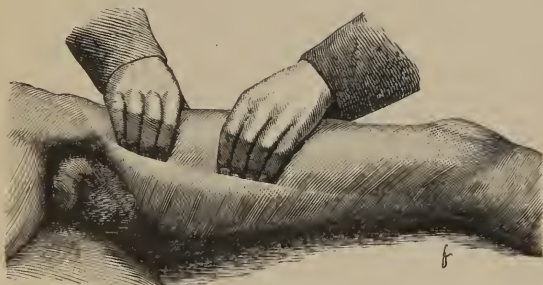
ing, since we have no lack of excellent treatises on this subject; they, then, are without excuse who commence the study of operative surgery with insufficient anatomical knowledge. Supposing, therefore, my reader to be an experienced anatomist, it will be necessary for me repeatedly to recall to his mind the relations between the arteries and the organs (nerves, muscles, bony protuberances, etc.) which constitute the *points of repair*, or landmarks,—the sign-posts placed along the route, to be consulted by the operator who wishes to go surely to his aim.

§ 1. The first paragraph of these generalities, as well as the first phrase of each particular article, ought to be purely anatomical. On setting about the discovery of the common arterial sheath, before cutting it is necessary to demand *where* one is going to cut; that is to say, to determine and *trace on the skin* a line corresponding as perfectly as possible to the track of the artery. This preliminary search or tracing is very important; for when one makes the incision in the proper place he almost always finds certainly and successively the artery in its relations.

To trace upon the skin the *line of operation*, that is to say, the track of the common arterial sheath, we have to draw upon our memory with both eye and finger,—memory furnishing the anatomical knowledge. Exploring the region,

the eye sees the reliefs, the depressions, the folds, and the veins, and appreciates the distances; the finger perceives the bony tuberosities, the depressible muscular interstices, and sometimes even the beatings of the artery in some part of its course. During the exploration, also, we may order the patient to contract his muscles when we trace the line before anæsthesia.

FIG. 1.



MARCHAND.

Exploration of the region.—The hands exploring the muscular groove or route of the common sheath (*the thigh taken as an example*).

An example will suffice to show the rigorous precision with which we ought to proceed in the first steps of the operation. I will suppose it necessary to mark out the track of the radial artery (Fig. 2). 1. We know that this vessel at its origin corresponds with the middle of the fold of the arm at the elbow. It is necessary for us then to seek first for the fold of the elbow, by flexing the fore-arm; next, carrying the fingers

over the lateral tuberosities of the humerus, which are at the extremities of this fold, we determine the middle point, and mark it with the tincture of iodine.¹ 2. At the wrist the radial artery passes along the hollow formed by the palmaris longus and the supinator longus, a depression which the finger is accustomed to explore in feeling the pulse. We trace a straight line from the middle of the bend of the elbow to a point where the pulse is perceived, and we have our line of operation, whether we wish to ligate the artery above, below, or in the middle of the fore-arm. But two safeguards are better than one, making, so to say, the proof of our operation: the radial artery continues from the brachial to the inner side of the tendon of the biceps, so that the finger can easily recognize it; there is the middle of the fold of the arm; and from this our line of operation ought to proceed. Furthermore, the vessel runs its course in the fore-arm in the groove separating the epitrochlean from the epicondylean muscles, and this groove, while slightly visible to the eye, is especially perceptible to the fingers; if it corresponds to

¹ I would recommend in all cases the tincture of iodine, which dries rapidly and is immediately visible. It is preferable to ink, which does not dry so rapidly, and to the nitrate of silver, which only blackens by the next day, and to the dermographic crayon, which does not mark at all upon the cadaver.

our line of operation, there is no doubt of the latter having been properly traced.

FIG. 2.



Tracing of the line of operation (*radial taken as an example*).—

To find the middle of the fold at the elbow, the surgeon inspects the member, facing it, with his left index-finger upon the epicondyle, which he presses down upon through the overlying muscles. The forefinger of the right hand he places upon the epitrochlea, and the thumb upon the middle of the fold of the elbow, on the inner side of the bicipital tendon. From this point a line drawn through the pulse-groove marks the track of the artery.

It is by this precise minuteness in mapping out on the skin the course of the artery before we touch the bistoury that we are assured of

success in the operation. "Undoubtedly," says M. Chassaignac, "the most important thing towards assuring immediate success in the ligation of an artery is the manner in which one places the incision of the skin."

Never, however, I would say, should we make our incision before having carefully explored the region, to recognize the large veins, normal and abnormal, the arteries accidentally superficial, etc., but especially to determine the track of the artery. It is here that we see the importance of anatomical knowledge on the part of the surgeon.

§ 2. The line of operation having been determined and traced with iodine (an excellent precaution for everybody), *we incise the skin* upon this line,¹ for a certain distance, with a single sweep of the bistoury, and always from left to right. The integument in the course of the bistoury would glide off if the left hand of the surgeon applied to the limb did not fix it without displacing it. The skin should be cut through its entire thickness, from one end to the other of the incision; that is to say, no *queues* should be made,—for this is what we call the two extremities of an incision, which become more

¹ When the necessary incision would correspond *longitudinally* to a large superficial vein, it is permissible, though only in such a case, to turn a little aside from the line of operation, in order to avoid wounding the vessel.

and more shallow from the middle. The queues, it will be found, have only gone through the most superficial layer of the skin; they are painful, slow in cicatrizing, and avail nothing by their length in the incision, since they permit no separation of the wound.

To avoid them, we should commence the cutaneous section, holding the bistoury almost straight, puncturing the skin with prudence, then depressing the cutting edge for the purpose

FIG. 3.



The hand holding the bistoury like a writing-pen.

of cutting more easily, and restraightening the instrument on concluding the incision.

As to the manner of holding the bistoury, it does not matter much. If you wish precision, hold it like a writing-pen (Fig. 3); and if you wish force, hold it as you would a table-knife (Fig. 4).

The last mode is the classic and traditional one for incision of the skin. In both cases, it would be better to support the right hand upon the subject than to operate with the hand raised

clear. In a dangerous region it is best not to cut too boldly, even at the risk of having to pass the bistoury twice over the track of incision.

FIG. 4.



Incision of the skin (*radial taken as an example*).—The left hand fixes the skin, the index-finger resting upon the track of the vessel and marking the point of commencement of the incision, the right hand resting upon the patient through the three last fingers, and holding the bistoury like a carving-knife.

The skin is never to be incised until some precaution has been taken against wounding the larger veins and lymphatic ganglia, etc., by an exploration of the region.

The cellular tissue ought always to be cut through its whole thickness, from one extremity of the wound to the other, so as to lay bare the aponeurosis. To do this, the left thumb and index-finger should be applied to each side of the wound, separating *equally* the lips, without drawing them over to either side. If we would properly lay bare the aponeurosis and guard against cutting it, we will have to make a good many strokes of the bistoury in cutting through the

cellular tissue, comprising the fascia pellucida (the deep layer, deprived of fat), which, if it is not divided, ecchymoses easily, and masks the fibrous tissue.

§ 3. The aponeurosis is exposed; we see it, and touch it. Then we cut boldly with the bistoury from one end of the wound to the other, or, in case it covers some important organ, we pass beneath a grooved director, which is introduced at one end of the incision and brought out at the other; we now assure ourselves that only the aponeurosis is over the director, and this being fixed by the left hand, which steadies it, the right slips the bistoury into the groove and makes the incision without any danger. Finally, the aponeurosis is again explored, to see whether it contains or exposes to view any landmark. Through its transparency we may perceive the muscles, the superficial arteries, the muscular interstices when they are filled with yellow fat,¹ and those interstices which yield to the pressure of the finger, or, on the contrary, resist by the presence of a strong intermuscular partition placed in the field.

¹ These yellow lines, points of repair or landmarks, pointed out by all the authors, are not entitled to the importance given to them. They fail in most of the regions in emaciated subjects, and are only visible upon the cadaver, which does not bleed. It is the finger we ought to have recourse to upon the living: it alone sees clearly to the bottom of wounds filled with blood.

After this inspection, we incise the aponeurosis in the manner spoken of above, with a bold stroke of the bistoury from without inwards, or from within outwards, on the grooved director, without any danger.

§ 4. It is usually after a section of the aponeurosis that we proceed to seek for the landmarks, which are almost always muscles, tendons, nerves, and bony prominences. It is the index-finger of the left hand which explores the bottom of the wound, gently separating the organs; the grooved director held in the right hand serving to tear the cellular tissues, and thus permitting the finger to penetrate deeper and still deeper. This work of the left index-finger ought to be facilitated by two assistants, one to hold the relaxed member, flexing slightly the muscles among which the artery is to be sought, another holding the two lips of the wound open to their depth, either with the fingers or with proper retractors. If the wound is well cleansed, the operator can then see clearly;¹ but when a landmark has been discovered, whether by the finger or the eye, it is imperative that we should look at it,

¹ It has very reasonably been recommended that we should operate dry,—that is to say, tie all the arterioles involved. We may thus see a little more clearly, and have no fear that the arterioles which had spontaneously ceased bleeding would re-open and bleed afresh on being dilated, on the application of the ligature.

and touch it,—*reconnoître* it, in a word. Then, recalling to memory the relations of the vasculo-nervous mass, we have our indications for proceeding with the operation. In many instances (ligation of the axillary, carotid, lingual, etc.) there are numerous organs encountered which can serve as landmarks; and these we ought to discover and observe in succession.

Finally, *step by step*, we arrive at the vasculo-nervous sheath, more or less marked by an aponeurosis, which the point of the director can usually open up, but which sometimes one is compelled to cut carefully upon the grooved director. The vessels and nerves, united into a bundle, are, like the muscles, ensheathed by aponeurotic envelopes; but this *fibrous sheath* is often reduced to its superficial cover, which attaches the vessels to the subjacent organ, and is almost always very thin and transparent. In the most ordinary cases we neglect it entirely, and without opening it proceed to the diagnosis of the parts composing the vasculo-nervous bundle,—a diagnosis sometimes delicate, and requiring important anatomical knowledge.

§ 5. Each large artery is accompanied by one large vein, supplied by one or many derivative canals, irregularly placed beside the artery, but which, fortunately, may be interfered with without danger. The arteries of medium and small size are placed between two veins of nearly equal size, which present frequent

transverse anastomoses crossing the artery above and below.

The three blood-vessels parallel and in apposition are placed in the midst of muscular beds: if the interstice is formed by two superposed muscles, or rather the one placed before the other, as in the region of the *tibialis posticus*, the veins are on each side of the artery; but if the interstice is antero-posterior, as in that which separates the *tibialis anticus* from the extensors of the toes, one vein is in front and the other in rear of the artery, which one cannot isolate without tearing loose the superficial vein, unless he attack the cellular sheath at the side.

The nerves are almost always more superficial than the vessels, and very often some distance from them; the sheath sought for is then simply vascular.

To denude the artery, it must be known where it is. The operator has the vasculo-nervous bundle beneath his eye and finger: how and by what means can he recognize the arterial portion of it?

In the cadaver the nerves are white, the veins black, and we see our way clearly. In the living subject the arteries beat, but not so much as one might think (Richet), and not always in the neighborhood of aneurisms (Hodgson); and their pulsations are not so limited that they are not seen across a nerve (S. Cooper) or a collateral vein; and, on the other hand, the blood masks the bottom of the wound. The pupil should never forget that in the amphitheatre he ought

to educate his finger rather than his eyes if he does not wish to find himself powerless when he comes to operate upon the living subject. It is, then, with his eyes in the air and his fingers in the wound, that he should habituate himself to tying arteries, the superficial incision once made. Listen to what Sabatier says: "The vessels, the nerves, the cellular tissues, and the muscles, which it is so easy to separate and avoid upon the cadaver, will appear uniformly colored by the blood, which colors and confounds them in the living to any but the able surgeon." And farther on,—“The eye, and especially the hand, of which the skilled operator makes such frequent and happy use, cannot be endowed with too much delicacy and dexterity: *the touch can never be too fine and skilled.*” This last proposition is especially applicable to the ligation of arteries and to the left index-finger, which is the principal agent in it. It is, then, with the finger, and with the eye as an aid, that the vasculo-nervous bundle is to be analyzed, by compressing the elements composing it upon the subjacent planes, and even between the fingers if these planes are not resistant, if one can do so conveniently. To sum up, we would say, to work a little but touch much should be the practice of the amphitheatre. It is thus we shall recognize the nerves, the veins, and the artery in the cadaver and the living: In the cadaver the nerves are round and

white, the veins full of black blood, the arteries are ribbons, grayish, rosy, clear, and sometimes yellowish, but in general of a characteristic color, which is not easily forgotten; their borders are thickened, salient, and clear. In the living, everything is red, or at least reddish.

Upon the cadaver the nerves give to the finger compressing them the sensation of a full cord which does not flatten out; the veins are ordinarily so thin that they cannot be perceived, while, on the contrary, the artery is thick, elastic, flat, hollow, and thicker at the borders than at the middle, resembling a caoutchouc tube, and presenting a tense resisting contour. If the finger hesitates between two cords, the memory intervenes to recall the respective contents of the bundle explored.

In the living the nerves give the same sensation to the finger which they do in the dead subject. Isolated, separated from the artery by a retractor, they do not beat, and have no appearance of beating. The veins swell up and harden if we press on them in the cardiac angle of the wound; the finger flattens them easily, and, in this condition, generally no longer perceives them. The artery, finally, beats, and these pulsations are of value in finding the vasculo-nervous band rather than in isolating its elements. They increase on compressing the distal angle of the wound, and generally cease on compression in

the cardiac angle. In both cases the region supplied by the artery ceases to receive its blood, the aneurism ceases to beat, and hemorrhage is suspended. But the pulsations of an artery which is nearly denuded are not all sufficient for its finding, and it is still by flattening out the vessel beneath the finger, and by seeking to find those characteristics presented by it in the cadaver, that a diagnosis is surely to be reached. To conclude, when one ligates upon a wounded person an artery which an assistant compresses higher up, he finds pretty much the same conditions to exist as when operating on the cadaver in the amphitheatre.¹ When the vessel sought for does not rest upon a resisting plane (the lingual, for example), we ought, as we advance in the incision of the soft parts, to twist the arterioles and sponge out the wound well, so as to gain a clear view, the touch here being insufficient.

¹ Happily, a practiced finger is full of resources; it recognizes and distinguishes between the arteries, the nerves, and even the little flat muscles: "The cord-like nerves and the smooth flat muscle may thus (by the touch) be readily distinguished." (J. and R. Quain and Sharpey, *Anatomy*, art. *Subclavian*.)

ARTICLE II.

ISOLATION OF THE ARTERY.

The situation of the artery having been determined, and an assistant keeping the wound open by aid of the retractors *placed in position by the surgeon himself*, the time has now come to open the cellular sheath in order to pass the thread beneath the artery and to compress it alone in the ligature.

§ 1. I have hitherto pointed out the relations of the vasculo-nervous elements; now, however, I am obliged to say something regarding the structure of the arterial sheaths.

The arterial walls are formed of three enveloping tubes, the structure of which presents distinct differences, but which are not separable except by dissection. The internal tunic is thin, elastic, and fragile; the middle, while it is elastic and muscular, is also very fragile and thick; the external, finally, is midway between the two preceding in thickness: it is formed of connective tissue and elastic fibres, especially accumulated around its deepest layers; it is especially vascular, resisting alone the constricting thread, and plays the principal rôle in the cicatrization of the other tunics broken by this thread. It is sufficient to allow it to remain intact, to give hope of suc-

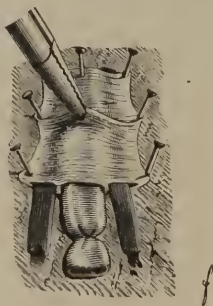
cess in ligation. It would be wrong to open this external tunic to apply the thread directly to the middle coat, which is cut even more readily than the internal. Those surgeons who imagine they open the adventitious tunic do not do so, fortunately for their patients. At the most they dissect up a thin superficial lamina, easily pinched up; but they leave in all its integrity the deep thick bed, formed of the solid interlaced bands, and strongly applied by its elasticity to the middle tunic, whose tissues and its own are in continuity, despite the rapid changes observable at this point in the structure of the arterial walls.

Composed thus of three very adherent tissues, the arterial tube, whether isolated (subclavian) or accompanied by veins and nerves, is lodged in a sheath of laminar tissue (*cellular sheath*), like a tendon in its sheath, with this difference, that the isolation and mobility are less for the artery than for the tendon. Thanks to this disposition, the artery glides smoothly at each cardiac pulsation; cut across, the two ends separate, and retreat deeply into the sheath; suppuration can, by infiltration around the arterial tube, destroy the adhesions of the *vasa vasorum* going to the external tunic, and cause that inflammatory friability which was so much dreaded by Dupuytren, but which seems to be an exceptional thing. Finally, as soon as the sheath is opened, it becomes easy to pass a thread beneath the vessel. There is then around the arteries a species of incompletely-developed mucous covering, which might be called the *periarterial serous cavity*. A tendon, the synovial covering of which has been once inflamed, and has numbers of adhesions, will

present analogous conditions. The mobility of the artery in its sheath is lessened by divers causes, and can be destroyed by adhesive inflammation to such a degree as to render the denudation extremely laborious.

The veins and the collateral nerves are alike ensheathed; and it is in the same mass of cellular tissue that all the cords of the vasculo-nervous bundle are contained, which have each their particular canal, just as we might have two or three glass tubes piercing a cork. When one has the misfortune in operating with the grooved director to loosen the vasculo-nervous bundle of the deep planes, he experiences the greatest difficulty afterwards in separating the veins from the artery, since the whole mass is now unfixed.

FIG. 5.



An artery, with its veins and the cellular sheath inclosing it, fixed upon a cork. The artery has been corrugated by a temporary ligature. A pair of forceps lifts up a transverse fold of the cellular sheath, as it ought to be for the denudation of an artery by a bistoury.

§ 2. It is, then, upon the artery itself that we ought to open the cellular sheath, and this to

but a very small extent, say five to ten millimetres, in order to destroy the least number possible of the *vasa vasorum*, so as not to expose the vessel to gangrene and the future clot to softening. This is of the highest importance. Two processes are employed for denudation of the arteries,—*tearing* with the point of the director or forceps, and *cutting*.

The incision of the sheath of an artery is a delicate and very irksome operation for beginners. Unfortunately, it always requires a good light. The following is the process: The left hand, armed with a good pair of forceps, seizes and

FIG. 6.



Denudation of an artery, first step (*radial taken as an example*).—The points of the forceps, at first separated and placed on the artery in its length, have been pressed together; the transverse fold of the cellular sheath thus formed has been gently lifted up, and the point of the bistoury applied to the incision upon the artery.

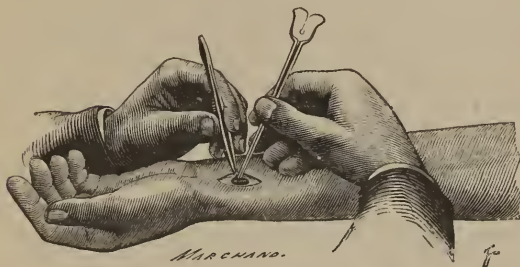
lifts up the cellular sheath, to permit the right hand, armed with a bistoury, to open it without

wounding the vessels. To do this, we should hold our forceps-points slightly separated (five to ten millimetres), and, applying them lightly *upon* the artery in the direction of its length, nip up and elevate a small *transverse fold*, as in Fig. 6.

By proceeding in this manner we hold only the cellular sheath, while if one makes the seizure transversely he risks taking up a longitudinal section of the artery, or one of the veins. The sheath being elevated, we incise the *transverse fold* with the point of the bistoury, which ought to be used prudently, and only upon the middle of the artery, which is thick, so that we shall not pierce the thin walls of the veins; one may also tear it open with the point of a blunt instrument. A longitudinal orifice, of ten millimetres at the farthest, having been made, the forceps, which has not let go its hold, separates one of the lips of the little wound; the point of the director unloosens the external tunic of the artery, by destroying the adhesions which the periarterial serous membrane presents as an obstruction, by to-and-fro movements, and then an effort is made to engage it beneath the vessel (Fig. 7). It now rests there an instant to serve as a support, while the forceps proceeds to seize the second lip, which is in its turn denuded, to engage finally the director under the vessel, where the instrument bearing the ligature follows. In every case the point of the instrument engaged on one side beneath the

artery cannot easily emerge from the other side, if the forceps should not be brought back and

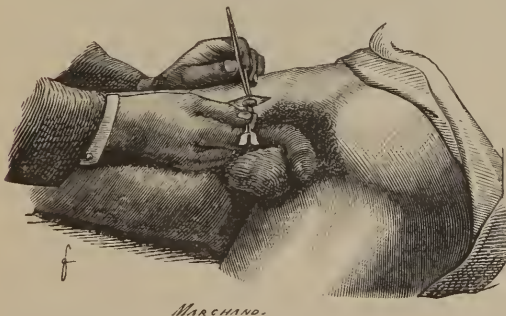
FIG. 7.



Denudation of an artery, second step (*radial as an example*).—The cellular sheath is opened, the forceps holds the internal lip as the point of the director is in the act of denudation.

seize the corresponding lip, to separate and lower it (Fig. 8).

FIG. 8.



Denudation of an artery, last step, and passage of the needle armed with ligature (*femoral as an example*).—The second lip of the sheath (the internal) has been denuded by the point of the director, which rests engaged beneath the vessel; the forceps is in the act of seizing the external lip and drawing it down, to permit the director (or an instrument bearing a ligature) to free it without danger, for charging the artery.

The denudation by forceps and bistoury is certainly the most surgical method. Thus one will not bruise the tissues, and if the patient has not been anæsthetized he will certainly suffer and complain less. But it is necessary to see clearly. Consequently it is well to practice the denudation

FIG. 9.



Denudation of an artery with forceps (*epigastric as an example*).—The two forceps having seized the cellular sheath at the same point, each draws it in an opposite direction, in order to loosen and expose the artery sufficiently.

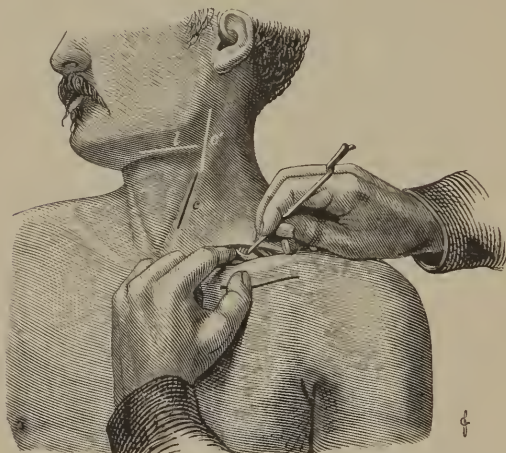
of arteries without the assistance of a cutting instrument, which is always a little dangerous in the hands of a person who has not a clear view of things.

After having properly raised up the sheath, if we find ourselves embarrassed by the blood, we can lacerate it with the point of the director, supported by the middle finger, which steadies it and prevents it from slipping; we may then assist ourselves by a second pair of forceps in separating the periarterial cellular tissue, layer by layer, if it is thick and resistant; this, indeed, is the only way of easily detaching an artery so mobile as the epigastric (Fig. 9).

Very frequently we may do without the forceps and bistoury; while the index-finger is at the bottom of the wound, near the artery, which it perceives, the right hand carries the grooved director perpendicularly down upon the vessel, and endeavors to tear the sheath by rubbing it with the point of the instrument (Fig. 10). The grooved director, supported and fortified by the right middle finger, and buried along with it in the wound, can effect the object only by the almost cutting edges of the hollowed point; otherwise it slips and does not penetrate. It ought also to be perfectly perpendicular to the artery. When we do this, we will pass through the periarterial tissue and push it aside successively towards the proximal and distal sides, keeping in mind to make a half-turn of the director, the hollowed side of which, I repeat, can alone attack it to advantage. Prudence generally demands that we should go slowly and

take our time. The exploring index-finger follows up the denudation, and as we succeed in passing the director or the artery-needle

FIG. 10.

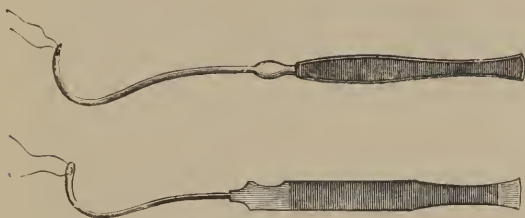


Denudation of an artery with the director (*the subclavian as an example*).—The instrument, supported by the point of the middle finger, is carefully rubbed against the vessel, penetrates the cellular sheath, and lacerates it.

beneath the vessel, it is that which protects the organs and receives the point of the instrument against the pulp, and brings it out without danger. This kind of denudation is not applicable to the fragile atheromatous arteries; it demands of the vessel soundness and fixedness, and succeeds especially when the sheath is thin and not too firm.

§ 3. Passing the director beneath the artery is called in professional parlance *charging* the artery. The best instrument for charging an artery without lifting it up or running the risk of breaking it, is the needle of Cooper (Fig. 11).

FIG. 11.



Cooper's artery-needles.

It suffices for all cases: neither the grooved director of Cusco, the stylets, nor any of the straight instruments, are applicable to the ligation of the deep arteries. The most poorly-furnished practitioner always has in his case a curved needle, and a pair of forceps capable of fixing it firmly in its axis or in the side like a dentist's crotchet: if he will break the point of his needle, and carefully grind or file the point smooth, and thread and mount it, he will then have an extemporized artery-needle, which can even serve him for the ligation of the external iliac or the trunk of the *arteria innominata*. Whatever may be the instrument with which the artery is charged, we should manœuvre with

caution, so as not to infringe upon the veins or the other neighboring organs. The rule is to conduct it upon the left index-finger, and to engage it first on the side where there is danger, to reappear on the other side, where the finger conducting it proceeds to receive it, as has been described above.

For example, we charge the primitive carotid from without inwards, because the enormous, thin jugular vein is to the outer side. The manœuvre is much easier when one operates with a wide open wound, where he can denude with the forceps and the bistoury.

After the artery has been charged, it is necessary a last time to carry the finger over it, to reassure ourselves: 1. that in compressing or pinching the end which has been elevated, we suspend the course of the blood in the region supplied by the vessel sought,—that is to say, become satisfied that we have actually found the artery; 2. that the cord flattens out perfectly under the finger, and that consequently we are not about to tie anything else than the artery.

ARTICLE III.

LIGATION OF THE ARTERY.

This last exploration having given the results we expected, and the artery-needle having been withdrawn, there is nothing to do but knot the two ends of the thread. But where, and how?

The artery is denuded to a certain extent, say about a *centimetre* (about one-third of an inch), and the thread can always be applied more or less high: it is not a matter of indifference to us how we tie it. In truth, when one makes a ligation he purposes to obliterate the *two ends* of the vessel, and not merely the proximal termination of it. He ought then to make it his aim to place the thread at a certain distance from the trunks of the collaterals, by which the blood will continue to flow whether these vessels appertain to the cardiac or to the peripheral end. And in the possible case where, to avoid a superior collateral, one would have to risk approaching too closely an inferior collateral, capable of supplying blood in great quantity, it behooves him unhesitatingly to embrace this also in his ligature, and to prolong his denudation a little for this purpose.

Generally we tie at the middle of the denuded

part, which ought to be short, for there are reasons for fearing that the coats of an artery deprived of its cellular sheath to any great extent cannot produce a solid obliteration.

This is the moment to tie the knot. We make a half-knot, and draw it very tight in order to break the elastic tunics; then, letting go the thread just so as not to permit the portion made to become unloosed, we finish the knot, which ought always to be left *straight*, as represented in Fig. 12, so that it cannot unloose itself, as might happen in the case of a knot such as is represented beside it (Fig. 13). It is not necessary to draw it exceedingly tight, especially

FIG. 12.



Straight knot, very firm.

FIG. 13.



Oblique knot, which is not firm.

when there is put on in the continuity of the vessel a ligature which has no chance of slipping. To break the elastic tunics, a moderate constriction, provided it is sudden and perfectly circular,—not oblique,—suffices always. This is true even if we ligate the vessels cut at the surface of a stump; only it is necessary to embrace in the ligature all the circumference of the artery, without which the thread slips. With

a view of gaining an experience of the resistance of the arterial tunics, and the sensation they give to the fingers when they are cut by the ligation of the thread, it is indispensable that one should practice the ligation of bare arteries on the cadaver. But this is not the custom with pupils; and yet most of them subsequently, employed as aids rather than as operators, have scarcely anything else than this to do. It behooves us to learn to tie with just proper force, for if we draw too hard we are liable to two accidents: 1. Cutting the artery. This is frequently the case in old people, and in patients with aneurism: fine threads, perfect denudation,¹ and strong constriction are applicable to sound arteries only. 2. Breaking the thread. This is apparently nothing more than a subject of mortification to the operator, who accuses the thread of unsoundness, and forgets to blame himself for not having tested it. But—and this is the principal point—it is necessary to recharge the artery, and to repass a loop at the same place; for, if we put it beside the place of the first ligature, who knows but that, some days after

¹ We no longer interpose a foreign body—a roll of diachylon plaster, or something else—between the thread and the artery, making what was called a mediate ligature (Scarpa, Roux). However, many surgeons recommend that when we have to do with a friable artery we ligate with it as much of the cellular tissue as possible. Wenzel von Linhart (*Compendium der chirurgischen Operationslehre*) gives this advice.

the operation, when the clot is yet but slightly adherent to the soft cicatrix, and the part strangulated by the first ligature, and half cut in two, and perhaps gangrenous, it may give way?

The thread, especially when it is not well waxed, always imbibes blood, and slips in the fingers when we wish to tie the knot. This inconvenience can be avoided by wrapping the two free ends around a finger of each hand,—the little or ring finger,—in order to hold them firmly, while the two thumbs, touching back to back, force themselves like a wedge into the wound, between the ends, which are under the control of the fingers. It suffices then, to tie the knot well, to separate forcibly the unguis extremities of the thumbs, which, all the time in contact with each other, furnish a *point d'appui* by their phalangeal articulations (see Fig. 14). By this method we have great precision, and with a single neat effort, with but moderate force, and without trembling, we make our ligation, for the two hands are in contact. Frequently the ligation is made with the index-fingers placed back to back, like the thumbs: by this method there is less precision and force, but greater facility in making a ligation at the bottom of a deep wound.

In the amphitheatre, upon the cadaver, we may observe the immediate effects of a well-applied ligature. The artery is puckered up; two of the tunics, the internal and middle, being

completely broken, are, especially if the thread is large, even slightly curled up on each side in the calibre of the vessel: they are sufficiently well curled in to unite with each other, by virtue of the materials appertaining to the external tunic, and by aid of the retention caused by the constricting thread, which ought to remain on permanently. In the living, this work of cicatrization is done before the fall of the ligature, but in the mean time there forms, in the first hours ordinarily, an intra-arterial clot, adherent to the curled-up portion of the broken tunics, and mounting up to the first collateral. This clot, with certain modifications, remains, and plays a prominent part in hæmostasis; and it is necessary, in favoring its production, to ligate far from the collaterals, and in its preservation not to denude the artery to too great an extent. I ought, however, to say that this clot is not indispensable: the cicatrix of the tunics has been shown to be sufficient, but it is then that it is especially important to preserve the *vasa vasorum*: that is to say, brevity in denudation is necessary. In fact, I have seen an external carotid artery well obliterated, and without an appreciable clot; the ligature had been carried up to the origin of the vessel, very near the superior thyroid and the internal carotid. But this last, by its anastomoses at the base of the brain, presents a channel so freely open to the blood that we can scarcely compare

it to an ordinary collateral, which, whilst it permits the movement of the blood, shows itself insufficient for its flow: hence there result violent shocks and dilatations of the artery at each ventricular systole. I would reproach myself with having mentioned the possibility of success in ligating near a collateral, if I did not here once more repeat, that it is necessary at any price to try and avoid this practice, and endeavor to unite the two factors of obliteration,—the clot and cicatrix.

In order more fully to show the utility of the clot, I would recall what, unfortunately, we have had too frequent occasion to observe,—hemorrhages by the peripheric end of the artery after the fall of the ligature. The cicatrix has been equal in the two ends if the ligation has been done in the middle of the denuded part; but in the peripheric end, at first deprived of blood almost entirely, the clot is always slow of formation, very small, and in half the cases, indeed, absent: hence it results that on the fall of the ligature, or the gentle division of the external tunic, there is nothing but a fragile barrier opposed to the blood brought by the dilated collaterals, and hence a frequently possible rupture of the cicatrix, and a hemorrhage.

After having shown at length the proper mode of ligating an artery in its continuity, it is well to go over the rules of this operation, and to point out the dangers which lie along the route.

The surgeon, having placed his patient, and taken his own position, explores the region and traces the line of operation; he incises the skin, the cellular tissue, the aponeurosis, searches for and detects the landmarks, and arrives at the vasculo-nervous bundle. The muscles being relaxed by an assistant, who holds the limb and keeps the wound open by the retractors, the operator recognizes the artery, denudes it, charges it, and then contemplates it for the last time. Before ligating it, he chooses the point of the artery he is going to constrict, after which he cuts one of the free ends of the ligature and fixes the other outside, without attaching it to the dressings.

The following are the avoidable errors, most of which, if not all, have been committed upon the living. They are included under four heads,—inattention, ignorance of anatomy, maladroitness, and inexperience:

Searching for an artery in its usual locality, if perchance it is superficial: we ought to perceive this, in exploring the region: *e.g.*, the ulnar for a wound of the hand or wrist.

Making a *false route* because of neglect to trace the line or successively recognize the landmarks. This is the most common fault, and perhaps the easiest to avoid. In case of an anomaly, one can always arrive at the place of the vasculo-nervous bundle, occupied by the nerves, with an

arteriole and two veinules, which take the place of the displaced vessels.

Making a false cut ; cutting a large vein ; tearing a nerve ; opening the sheath of a tendon, or, more commonly, entering into a muscle in thinking to open an interstice.

During the denudation, perforating the artery or a neighboring vein ; depriving the vessel of its adventitious tunic along with its sheath, thus destroying it for too great a length. On the other hand, incompletely denuding it and charging it to run through another organ, an artery even,—or perhaps to break the vessel in lifting it up, and uselessly bringing it outside.

Finally, in ligating a vein, a nerve, etc., with or without the artery ; cutting the artery, by too tightly compressing it ; breaking the thread ; not drawing it tightly enough, or ligating obliquely ; or unloosening the first half-knot while in the act of making the second.

CHAPTER II.

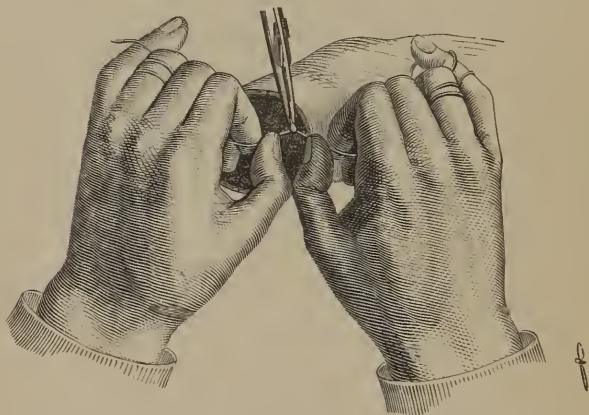
THE LIGATION OF ARTERIES CUT ACROSS
BY INCISION.

STUDENTS ought to practice the ligation of arteries on the surface of stumps in the dead-house. I wish no other proof of what I say than what may be seen in the hospitals of Paris, when a surgeon makes an amputation.

To do the thing *tuto, cito, et jucunde*, the concurrence of two persons is necessary: the one for seizing the artery and drawing it out, the other for throwing the thread around the vessel and tying it. If the forceps which has seized the artery—and this is sometimes done with difficulty—can draw it out, the ligation will be easy; but sometimes we cannot bring the artery to a level with the other soft parts. Be this as it may, the ligature is thrown beneath the forceps, which is first held in the axis of the vessel, and then changed to a perpendicular position, which causes the thread to slip beneath the bite of the instrument, which the ligator aids in, by the employment of his fingers. He then makes below the first half-knot, which he sinks deeply

around the vessel before he closes it in the ordinary way. I have seen assistants who did not know how to ligate, but I have also seen surgeons who did not know how to present the artery, or, at least, who were neglectful of doing it, thus rendering the work of the assistant extremely difficult.

FIG. 14.



Tying the thread.—The forceps holding the artery has been turned upward. The main line of the thread is tied, the ends being wrapped around the last two fingers of each hand. The thumbs touch back to back, and are bent away from each other at their first phalanges.

One may take up the arteries of a stump unassisted. "Once seized with this instrument (the artery-forceps), we abandon it to its own weight. The artery will be a little elongated, though not enough to do any harm; and now, both hands free, the operator can easily throw

the ligature around the vessel" (Ribes). In this manner, which is one frequently employed, the ligation is made above instead of below, as when the surgeon himself holds up the forceps; care should be taken that the weight of the instrument does not tear the artery.

But when it is impossible to isolate the end of the vessel by drawing hard upon it with the forceps, we are obliged to have recourse to the tenaculum, with which we transfix the artery and adjacent tissues to make a mediate ligation.

It frequently happens that as soon as the instrument is withdrawn the thread slips and falls. This inconvenience is avoided by letting the tenaculum remain; only, instead of the ordinary instrument, there is inserted a simple pin, curved like a fish-hook, and mounted in a pair of forceps, and left in the wound after the ligation has been applied. A thread ought to be attached to the pin in order to be able to draw it away easily; and the point should be capped with a little ball of yellow wax, to *prevent the tissues being pricked*.

CHAPTER III.

OTHER MEANS OF OBLITERATING ARTERIES.

I do not here propose to describe all the processes which may be resorted to after the ligation. However, for properly executing the principal of them,—*torsion* and *compression*,—practice upon the cadaver is necessary, of which I shall say a few words. This is a subject again actually before us, and the immortality of Ambroise Paré promised by Malgaigne to him who shall find the means of obliterating arteries without leaving a foreign body at the bottom of the wound, seems constantly present to the minds of surgeons.

I will say nothing of *cauterization*, of chemical or simply mechanical *bouchage*, of the *seton*, of *acupuncture*, of *galvanopuncture*, of *mâchure*, of *inversion*, of *perplication*, of the *mediate ligature* with or without the *artery-compressor*, of *acupressure*, etc.,—processes either rightly abandoned, or easy of execution upon the living for any surgeon accustomed to the ordinary operations.

ARTICLE I.

TORSION OF ARTERIES.

Almost as old as surgery (Galen), the torsion of arteries was carefully studied at the commencement of the present epoch, by Thierry, Amussat, and their contemporaries, principally with a view of favoring immediate reunion in stumps. The attempt has also been made to twist arteries in their continuity, for the cure of aneurisms.

§ 1. **Torsion of the end of an artery cut transversely.**—We should distinguish two processes: A. *Simple torsion* (*refoulement aléatoire*); B. *Torsion with intent to compress*.

A. *Simple Torsion.*—Simple torsion is practiced thus: the end of the artery is drawn out and freed from its cellular adhesions; it is then seized

FIG. 15.



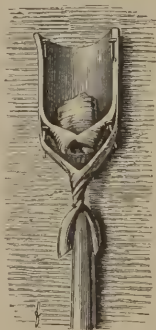
Pince à verrou with a large bite, for seizing and twisting the ends of an artery.

in the *large* bite of a pair of *very firm* bolt forceps (*pince à verrou*), and held in the axis of the vessel (Fig. 15).

Then, following this, we make a number of twists with the instrument, varying with the volume and condition of the artery, until it detaches itself, bearing the morsel with it. We may also stop before complete rupture¹ of the screwed portion, and leave the end of the twisted part in the wound; but it is then probably a useless foreign body.

When simple torsion succeeds well, the external tunic alone resists, and twists upon itself, whilst the two others, broken and denuded, are crowded into the calibre of the vessel. In Fig. 16

FIG. 16.



Fragment of the primitive carotid twisted and dissected (*exp. on cadaver*).—We see the elastic tunic almost regularly broken, and turned up. The adventitious tunic, twisted singly, is nearly broken.

¹ With this view, Bryant recommends the making of only ten turns for large arteries, six for the medium-sized, and four for the small. Hill, who has made seventy successful torsions, stops even sooner.

I have represented a successful simple torsion of the primitive carotid on the cadaver.

But, to succeed properly, it is necessary to twist a sound artery, and one deprived of its collaterals to the extent of about 0^m.01; and the artery must be seized and pinched firmly: it is also proper to break the elastic tunics at the point where we expect to see the torsion operate, and even sometimes to fix the artery, above this place of rupture, with passive forceps, to limit the torsion.

B. *Torsion and Compression*.—With the view of assuring the circular rupture and compression of the internal tunics, Amussat, holding in one hand the end of the artery in ordinary fashion, used a *pince à baguettes* (Fig. 17) in the

Fig. 17.



Pince à baguettes of Amussat.

other, to compress the artery transversely and break the internal tunics, while preserving the external tunic. With these forceps he commenced with pressure, and immediately thereafter, or simultaneously, twisted. Provided the rupture of the elastic tunics has been complete, torsion suffices to produce their crowding or

curling up. The bolt forceps will do very well for the end of the artery, if it has a square bite at the end, and is *as large as the vessel*.

Though torsion is generally applied to the small arteries, it is also applicable to the largest. I think, however, it becomes us to assure ourselves of the curling-up of the elastic tunics. But will the surgeon find in torsion, *well and opportunely done*, as much security as in the ligature? This may be, and I think M. Tillaux is about to prove it. Remark, nevertheless, the two points underscored. *Well done* signifies that it is more difficult to twist than to ligate; and *opportunely* may be interpreted that torsion is not applicable to all cases, like the ligature.

§ 2. Torsion of an artery in its continuity.—One way of entering upon the above process is to cut the artery across, and separately twist the two ends, which have previously been fixed, so that, the section being made, they may not retract too deeply within their sheath.

In passing under the artery a rigid straight or curved instrument, serving the purpose of the stick of a tourniquet, one may twist the vessel, which has, however, been first fully drawn out. It is possible to stop torsion when we will: if we go on to the point of rupture, the two ends rest enrolled like the two ends of a wire thread reunited by the forceps; torsion is not in the axis

of the vessel, and there is a loss of substance. Consequently, the longitudinal elasticity of the artery tends to destroy the reunion of the two ends, and to transform torsion into a simple breaking and probable curling-up of the elastic tunics.

I have endeavored upon the cadaver, by numerous experiments, to twist arteries in their continuity without perceptible loss of substance, and with or without rupture, just as I desired. The primitive instrument used by me was a small, thick, metallic disk, pierced according to its diameter. The two halves, articulated by a hinge at one end, can be separated, and, indeed, form a pair of forceps, the straight and roughened bite of which can be brought in contact and maintained there by a catch. The artery being denuded, I seize it in the instrument, which, inclosing it, breaks the elastic tunics and holds firmly the external tunic. The vessel then becomes the axis,—a little fixed pulley,—which may be turned in different ways. We may stop it when we wish, by opening the instrument which strangles the artery, and thus not break the external tunic entirely. Usually the elastic tunics are curled back on the two ends of the vessel.

ARTICLE II.

COMPRESSION WITHOUT TORSION.

Compression may be practiced with or without rupture of the external tunic in the two different cases. M. Chassaignac has given the result of linear *écrasement* in large arteries. The elastic tunics are compressed to a certain height, in a double sense generally, and often in an unequal manner; the external tunic is drawn out, and finally broken by crushing.

This process of crushing is insufficient to bring about hæmostasis in the larger arteries. It has, nevertheless, been revived lately, under the title of *constriction of arteries*, by Dr. Flcet Speir. This American surgeon seizes the artery with a hook, which he draws into a tube like the handle of a *serre-nœud*. He lets his instrument remain a variable time. One may thus, according to wish, have instruments graduated and operate with them, compressing the middle tunics of arteries of different volume, pushing the traction farther and farther, even to the point of rupture if desired.

Ligation and compression.—The following is the mode I have generally adopted for operating upon the cadaver. I ligate the artery in the ordinary

way, with a firm thread, drawn tightly, in order to break the fragile tunics, then, taking a plate of lead, horn, or other solid substance, I pierce in it a hole proportioned to the volume of the vessel. I engage the two free ends of the thread in the hole, and pass the artery through like a thread, either with a *serre-nœud* or with the fingers. The compression is double, and can be carried back to a half-centimetre on each side. We may take away the thread, or let it remain. In leaving it, we combine the ligature with a double compression, a process which, *a priori*, seems excellent for obtaining the obliteration of the two ends of the vessel. In removing the thread we do away with a foreign body, but we withdraw a support to the compressed portion. In the two cases, the tunics compressed together can make a little valve over the orifice of an adjacent collateral; as for the external tunic, it has not been torn in two, as in linear *écrasement*, and therefore remains for the retention of the compressed portion and to assist in the plastic rôle peculiar to it.

PART SECOND.

SPECIAL LIGATIONS.

CHAPTER I.

UPPER AORTIC SYSTEM.

ARTICLE I.

LIGATIONS OF THE RADIAL ARTERY.

THIS vessel may be ligated on the anterior surface of the fore-arm in all points of its track, and behind the carpus at the "anatomical tobacco-box."

A. In the anatomical tobacco-box.—On a level with the wrist the radial artery abandons the anterior face of the radius, and passes along the radio-carpal articulation, under the united tendons of the long abductor and short extensor muscles; after this it appears in the anatomical tobacco-box, the inferior part of which it traverses obliquely, then glides beneath the long extensor of the thumb, and, almost immediately after, perforates the first dorsal interosseous muscle to go to form the deep palmar arch.

The member to be operated upon should repose upon the ulnar border, fixed by an assistant, who with one hand holds the fingers, and with the other extends and separates the thumb from the hand, to make the tendons salient. The operator seeks the point of the radius. In the living he causes voluntary movements to be made, and marks the track of the tendons; he also makes the cephalic vein at the thumb prominent, in order to avoid it.

Between the tendons, at an equal distance from them and parallel to them,¹ and starting from the end of the radius, or 0^m.03 lower, cut the skin, and that only, in order to spare the cephalic vein of the thumb. Manipulate this vessel aside; cut the aponeurosis like the skin between the tendons, etc.; with the point of the probe, which tears loose the fibrous layers, search *deep* in the *inferior part* of the wound;² the artery here passes with its veins, bearing *obliquely* behind and below.

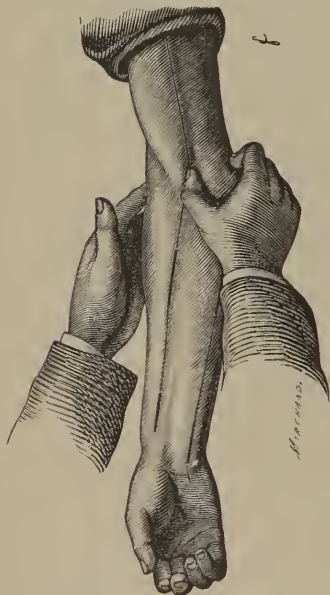
B. In the forearm the radial artery originates deeply, and descends, attached in front of the pronator radii teres, by an aponeurosis which covers the supinator longus (satellite muscle), and is itself covered by a

¹ It is necessary by all means to avoid opening the long sheaths of these tendons.

² At this level we operate on the dorsal face of the trapezium without fear of opening the articulation of the wrist.

superficial aponeurosis. Lower, the artery becomes sub-aponeurotic, almost subcutaneous, between the tendon of the long supinator and great palmar.

FIG. 18.



Determining the middle of the fold of the elbow.—The surgeon faces the limb. The left index-finger is upon the epicondyle, and presses up the muscles. The right hand has its index-finger upon the epitrochlea, and the thumb at the middle of the elbow-fold, on the internal head of the bicipital tendon. The line of the radial is traced in the antibrachial hollow.

The anterior branch of the radial nerve is outside the vessel (see Fig. 22). The track of the radial artery corresponds to the *antibrachial groove*, formed by the epitrochlean and epicondylean muscles.

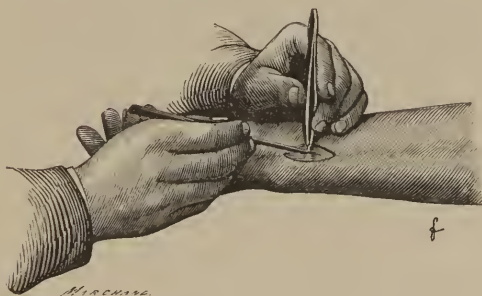
The operator first marks his line of operation from the middle of the bend of the elbow and within the tendon of the biceps, along the pulse groove; the whole length of the pulse-groove he should feel with his fingers (Fig. 18). He makes the veins salient in order to

avoid the great ones, and places himself on the

outside to operate. The member is laid in supination, and fixed by an assistant.

§ 1. **The inferior third.**—In the line indicated in the pulse-hollow, at a centimetre outside of the tendon of the palmaris longus and parallel to this tendon, and upon the artery, which may be felt beating, incise the skin lightly to the extent of 0^m.03.¹ Separate the lips of the wound; look at and touch the artery through the aponeurosis. Pinch up this aponeurosis, and cut (Fig. 19) or

FIG. 19.



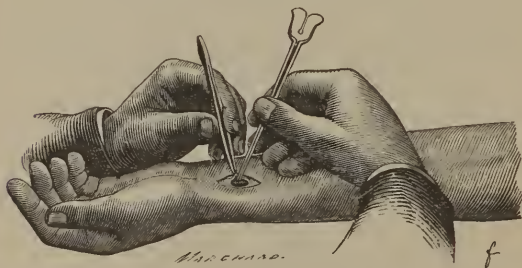
Ligation of the radial (beneath the wrist).—The aponeurosis is elevated with the forceps. The bistoury then incises the transverse fold thus formed, just down to the artery. The denudation is then to be made methodically, although, except for practice, this may be of little use, considering the small volume of the vessel.

¹ The incision may come out on a level with the inferior extremity of the radius, but ought not to descend farther. The radial artery, deviating in rear, cannot be sought for, like the ulnar, at the anterior part of the wrist.

tear directly down to the artery; isolate (Fig. 20) and charge it.¹

As in the case of all the superficial arteries, the radial ought, in our operations upon the cadaver, to be denuded with care. This gives a practiced dexterity to the hand.

FIG 20



Ligation of the radial (*above the wrist*).—Second denudation.

§ 2. **Superior third.**—The left hand fixes the skin, and its index-finger presses down in the groove, marking the point of departure of the incision (Fig. 21). Upon the line indicated, avoiding the large veins, make an incision in the skin 0^m.06 in length. Cut the cellular tissue and search anew for the antibrachial groove, which is generally white and fatty. *Upon the*

¹ When the radial is ligated immediately above the wrist, we do not encounter the satellite nerve, which has already been borne in rear of the fore-arm; when the ligation is made higher up, we still do not encounter it generally, unless it is sought for, since it is many millimetres outside of the vessels.

external lip incise the aponeurosis; recognize the internal border of the *long supinator muscle* thus exposed; leave it alone, or draw it gently outside.¹ Try to see or feel the artery as it traverses the deep aponeurosis which lies in front of the pronator radii teres and palmaris longus. Tear or cut this *second* aponeurosis. You should know that the small anterior radial nerve is outside the artery; but do not search for it. Isolate and charge it from without inwards.

FIG 21.



Ligation of the radial (*above the middle of the fore-arm*).—The left hand fixes the skin, and the index-finger buries itself in the gutter or route of the vessel. The right hand rests upon the arm of the patient by the last fingers, holding the bistoury like a table-knife.

ARTICLE II.

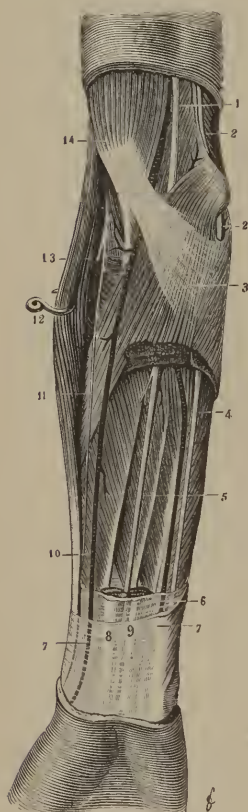
LIGATIONS OF THE ULNAR ARTERY.

The ulnar artery arises 0^m.02 below the bend of the elbow, and runs first inwards, beneath the epitrochlean

¹ In meagre subjects it is hardly necessary to push aside the muscle. It is only necessary to open the sheath and reveal the artery to keep in the proper path.

muscles and the median nerve, to reach the external side of the ulnar nerve (Fig. 22, 4), and become longi-

FIG. 22.



The course and relations of the arteries of the fore-arm.—1. Median nerve and brachial artery resting on the brachialis anticus muscle; 2, 2, ulnar nerve; 3, tendinous expansion of the biceps covering the anterior epitrochlean muscles; the flexor sublimis, palmaris longus, and brevis cut across, the pronator radii teres intact; 4, ulnar artery, approaching the ulnar nerve; 5, median nerve; 6, deep aponeurosis enveloping the ulnar artery, the ulnar and median nerves and the cut tendons of the flexor sublimis lying upon the flexor profundus digitorum; 7, cut tendon of the flexor carpi ulnaris and superficial aponeurosis; 7, the aponeurosis covering only the radial artery; 8, palmaris longus; 9, palmaris brevis; 10, radial artery resting upon the flexor proprius pollicis; 11, anterior branch of the radial nerve; 12, long supinator lifted up; 13, posterior branch of the radial nerve traversing the short supinator; 14, biceps.

tudinal, responding to the situation of the nerve in the lower two-thirds of the fore-arm, and the interstices of

the *anterior ulnar muscle* (satellite muscle) and superficial fascia of the flexor sublimis. It is not accessible in the beginning of its course for three finger-breadths, at least without cutting across all the epitrochlean muscles save the ulnar, besides risking a section of the median nerve. Below the three finger-breadths alluded to, and which ought always to be respected, the artery may be reached by the interstice indicated, but with the more difficulty the higher up one operates.

In their whole course the ulnar vessels and nerves rest upon the flexor profundus digitorum, in front of which they are closely attached by an aponeurosis, which is not seen near the elbow, but is very resistant near the wrist (Fig. 22, 6). In the lower half of the fore-arm the tendon of the flexor carpi ulnaris encroaches upon the artery, and still more so upon the nerve placed inwards: it is separate from the other tendons, and easy to find. But at the upper part the interstice which is to be opened is less and less visible as the epitrochlea is approached. In finding it we ought to recall the great breadth of the flexor ulnaris (about 0^m.03), and in opening it to remember that we will find an aponeurotic muscular partition, whose fibres on the internal face are interwoven with those of the ulnar flexor, and on the other side on the external face are simply in apposition with the flexor sublimis, which is only inserted high up on the fore-arm. However, since these last insertions may be continued lower down, we ought not when we separate the sublimis to introduce the grooved director into the upper part of the wound, for fear of entering the muscle itself, while following up its oblique fibres,

but rather by the lower portion of the wound, so as to separate the possibly existing insertions by working from below above.

In opening the interstices we will furthermore recall the fact that the ulnaris covers over the sublimis a little, and consequently that we should introduce the director obliquely, carrying it under one and the other in directing it outward.

To be prepared to find the ulnar artery at all points where it is accessible, it is sufficient to practice its ligation—1, just above the wrist; 2, above the middle of the fore-arm.

In both cases the fore-arm is supinated and drawn out from the trunk, and held by the hands of an assistant. The operator places himself on *the inside*, and traces the *line of operation*—from the epitrochlea to the outer side of the pisiform bone, upon the external border of the tendon of the flexor carpi ulnaris, which is easily perceptible in the lower half of the fore-arm (see Fig. 23).

§ 1. *Above the wrist.*¹—In the line indicated, immediately to the outside of the projecting border of the tendon of the ulnar flexor, where

¹ In manœuvring, as it is called, one can ligate up to a variable height, and even to the hypothenar eminence, outside of the pisiform bone. The artery, which is easily accessible up to 0^m.03 below this bone, rests upon the very strong annular ligament of the wrist, with the ulnar nerve to its inner side, and the cutaneous part of the palmar muscle covering them.

the artery¹ sometimes beats, make an incision of the skin 0^m.05 in length. Cut the superficial aponeurosis very near the border of the *ulnar tendon*, or even upon the tendon itself. Flex the hand to relax it, draw it inwards, and at the place where it ought to be, search for the artery beneath the deep aponeurosis, which you will cut on the grooved director. The nerve is inside of the vessels. Denude, and charge it from within outwards.

§ 2. *Below the middle of the fore-arm.*—The operator places himself to the inside, either in his seat or squatting down.²

On the line indicated, three finger-breadths beneath the epitrochlea, commence or terminate (according to the side) an incision of 0^m.07, which involves only the skin. Cut the cellular tissue carefully, the better to see the aponeurosis.

¹ We may feel, and even see, the pulsations of the artery on pressing back the hand, if the patient is thin. But when we perceive the vessel we can still better see the tendon; and it is this which ought first to be sought.

² For finding the artery at this level it is not sufficient to separate the muscles: it is also necessary to lift up the flexor sublimis, and to look beneath it. Every operator who places himself either to the outer or inner side of the limb and forgets to stoop down, is liable to fail in finding the artery. He seeks it in the flexor profundus, or rather to the inner side of it, between this muscle and the flexor ulnaris, towards the crest of the bone. If we stand upright, it is necessary to keep the fore-arm in a state of forced supination.

With the left index-finger draw down the lower lip of the wound, for exploring the aponeurotic surface of the flexor carpi ulnaris; recognize the white oblique-fibred sheath. Then, recalling it to eye and finger, stop upon the *first yellow interstice*, which is plainly visible and depressible in the lower angle of the wound; look at it and touch it. Near this interstice, but in front and to the outer side of it, incise the aponeurosis *upon* the flexor sublimis muscle: the muscle is by this made to bulge out. Then with the finger and director delicately open the interstice for the whole length of the wound, from below above; at the bottom is the ulnar nerve: recognize this. Keep your finger to the inside of the flexor carpi ulnaris, while an assistant draws aside and lifts up the flexor muscle, and flexes the hand to relax it. Beneath this muscle, and to the outside of the nerve, search for the artery, selecting by preference the inferior part of the wound in which to do so.¹ Denude, and pass the threaded curved needle from within outwards.

¹ One always finds there an artery with two veins. But these normal vessels are very small, and soon lose themselves, when the ulnar artery is subcutaneous,—an anomaly which ought not to pass unperceived on the living, since we should never make an incision upon the fore-arm without passing the hand over it, in order to assure ourselves that we have not an artery beneath the skin, and to make the large veins project in order the better to avoid them.

ARTICLE III.

LIGATIONS OF THE BRACHIAL AND AXILLARY ARTERIES.

(In the axilla.)

The line of operation, the proceeding, and the landmarks being the same for the two arteries, I have thought it proper to unite their ligation in the same article. Besides, I am sure that in the operation designated as ligation of the axillary artery in the axilla, it is almost always at the origin of the brachial that the ligature is placed.

When the axillary artery, emerging from the roots of the median nerve, becomes accessible, observe what are its relations in front; the median nerve covers it, and the coraco-brachialis muscle, perforated by the musculo-cutaneous nerve, covers the median nerve. Lower down, on becoming the brachial, its relations are not changed,—only the biceps replaces the coraco-brachialis, and the median nerve, always in front (save when anomalous), bears very gradually to the inside of the vessels, and in front of the brachialis anticus. The other components of the vasculo-nervous sheath, very closely connected with the artery in the axilla, soon disperse and cease to trouble the operator.

For reaching the artery in the axillary space we have the skin and aponeurosis to cut, the veins to avoid, and the nerves to draw aside. In the aponeurosis is the

basilic vein, mounting more or less high before it empties into the axillary vein, which is deeper, and furnished with a collateral vessel. To reach the artery by the shortest route, but the least sure and the most perilous, the operator will encounter a vein, then the internal cutaneous nerve, and afterwards the other nerves and veins, some of which he will draw forward, others he will push in rear.

In those very frequent cases of bifurcation of the brachial artery, there is one artery in the aponeurosis and another in the normal place. This I think never fails to be the case. It is evident that this last, and it alone, is the one we have to take up on the cadaver, where we cannot divine the existence of the subcutaneous branch.

The patient will be placed lying upon his back at *the edge* of the bed, the arm drawn out to a right angle, the fore-arm stretched to demi-supination, and held by an assistant.

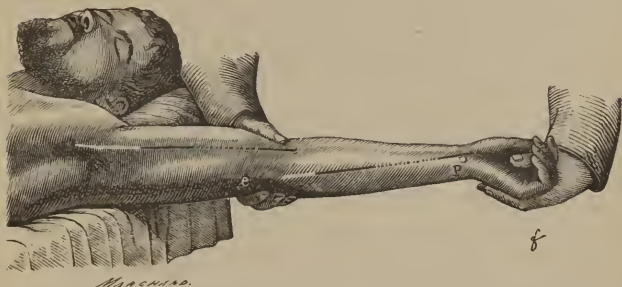
The surgeon places himself to the inner side, between the arm and the chest.

For tracing the *line of operation*, press the finger down into the upper part of the axilla, *immediately* in rear of the pectoralis major. From this point to the middle of the bend of the elbow (see next plate), trace carefully a straight line.

Assure yourself that it passes along the internal border of the coraco-brachialis and the biceps, the border of which you ought either to see or bring into relief by pinching up between the

fingers (see Fig. 23). You will still further examine by—1, compressing the axillary vein, to

FIG. 23.



Ligation of the brachial and ulnar arteries.—The limb is strongly stretched out from the body, and rests horizontally in the hands of an assistant. The surgeon places himself to the inside, traces either the line of the brachial, which passes along the biceps, or the line of the ulnar, which starts from the epitrochlea, *e*, to proceed to the outer side of the pisiform bone, *p*. It is on a level with the unbroken black lines that it is customary to make the incisions.

exhibit the basilic vein, in front of which the incision is to be made; 2, by running the hand over the arm, to perceive the arterial pulsations and the cord which the median nerve forms in thin subjects.

§ 1. **At the bend of the elbow.**—After having traced the line of operation, and caused the basilic vein to stand out in relief, flex again the fore-arm, to mark the elbow-fold.

To the inside of the biceps tendon, near the median basilic vein, at the middle of the fold of the elbow, cautiously make an incision of the

length of 0^m.06 (at the most), commencing at 0^m.03 above and finishing about 0^m.03 below this fold.¹ In cutting the cellular tissue, avoid the destruction of the vein, and push it to the inside. Recognize the strong oblique fibres and the aponeurotic expansion of the biceps; under this pass the canula, from above downward. Be certain, by means of the finger, that the fibrous tissue alone is lifted up, and cut it, holding firmly the canula and bistoury, which otherwise may slip out.² The tension of the fore-arm is relaxed a little, and the finger, in the axis of the wound, perceives the artery in connection with its veins, in front of the brachialis anticus, separated by a very thin aponeurosis. These vessels may generally be perceived.³ The denudation and the passage of the thread are easy, despite the mobility of the arterio-venous sheath.

¹ It is at the bifurcation of the artery at 0^m.02 below the fold of the elbow that the ligature is to be placed. This process permits the ligation of either of the front brachial arteries at their origin, by sacrificing the anastomotic veins.

² The bistoury has a tendency to shoot into the fibrous interspace, the fibres being oblique and crossing the incision at an acute angle.

³ It is not necessary to seek for the median nerve, concealed to the inside, under the pronator radii teres; but if we fall above it (in poorly-muscle subjects) it is necessary to bear outside where the artery passes. In the upper part of the wound the nerve is still sufficiently near the vessels to serve as a landmark, especially when in a fat subject we have to make a long incision.

§ 2. **At the middle of the elbow.**—In the direction indicated upon the internal border of the biceps muscle, cut carefully the skin (0^m.06), then the aponeurosis and cellular tissue. Follow the course of the bistoury with eye and finger, so as to avoid the basilic vein, and to perceive the superficial brachial artery in case of its bifurcation, which we should be on the lookout for. Coming to the *biceps*,¹ separate it well on its internal border, give it gently² to an aid, who draws it very lightly outwards, having flexed the fore-arm a little if necessary. At the place which the border of the muscle occupied, touch and examine the *median nerve*, move it with the director, and when it shall have been lifted outward if you operate very high up, and inward if very low down, the artery will be recognized in con-

¹ It is proper to search for the internal border of the biceps, under which is the artery (except in very poorly-developed subjects), and, consequently, to incise the aponeurosis over the muscle and open its sheath, the posterior expansion of which is too thin to hide the vessels and nerves lying underneath. In incising the biceps to the inside, and not opening its sheath, we are liable—1, to wound the basilic vein; 2, to ligate an abnormal branch of the artery; 3, and even to penetrate into the thickness of the internal inter-muscular partition, to discover the ulnar nerve accompanied by an arteriole and veinlets, sometimes sufficiently large to impose upon one.

² In order not to separate along with this muscle the vasculo-nervous bundle, which is beneath, and which is easily displaced, and especially so after the flexing of the fore-arm.

nection with its veins, lying upon the brachialis muscle, and may be denuded and easily ligated.¹

§ 3. **Ligation of the axillary in the axilla.**

—The patient lies upon his back on the border of the bed, the arm widely separated from the body. The fore-arm in mid-position,² and slightly flexed, is sustained horizontally by an assistant.

On the left side the operator takes his position to the inside, near the side of the patient, either sitting or slightly stooping.³ On the right, if he places himself in the same position, he will be hindered by the trunk,—that is, if he is not ambidextrous or left-handed; he will on this side place himself rather towards the neck, and operate standing over the shoulder, lowering the head to see into the axilla and make the incision in proper place.

The following description applies especially to the left side :

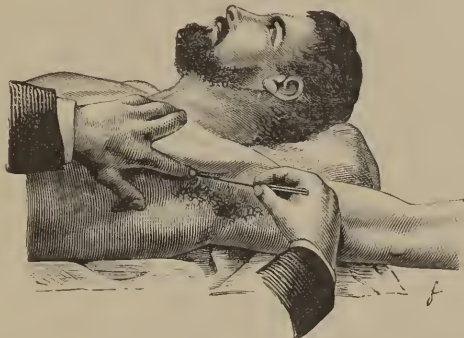
¹ If we operate very near the axilla, the first landmark is the coraco-brachialis: we should be directed by it, as we are by the biceps lower down. This causes no change in the operation.

² This is important, since forced supination twists the arm, destroying the relations which have been indicated, while it renders visible the perforating nerve, which ought to pass unperceived.

³ This is in order to cause the bistoury to play in a horizontal plane for reaching the coraco-brachialis muscle (first landmark), and not to let it go too far in rear, a very common fault.

Leaving the summit of the axilla, where the left index-finger is fixed (Fig. 24), *immediately* in

FIG. 24.



Ligation of the axillary artery (*in the axilla*).—The limb is well separated from the body, but not twisted. The index-finger finds and rests itself in the summit of the axillary depression, immediately in rear of the pectoralis major, where the incision is to be commenced. The bistoury is moved in a horizontal plane.

rear of the anterior wall, while holding the bistoury *horizontally*, make an incision of 0^m.08. Cut likewise cautiously the cellular tissue under the anterior lip of the skin. Between the thumb and index-finger feel the *coraco-brachialis*. Incise the aponeurosis *upon* the posterior border of this muscle. Observe it well: it is the first landmark. Isolate it by a stroke of the director, relax it by diminishing a little the abduction of the arm, and give it to an assistant, who will draw it forward; with a finger of the left hand¹

¹ If the surgeon is placed near the side, he generally feels

pressed down into the wound, crowd back to the rear all the vasculo-nervous bundle. Lift up your finger a little, and first a large cord will escape in front (that is to say, above, the patient lying down); it is free,—does not perforate the muscle (this is the second landmark,—the median nerve). Isolate it by a stroke of the canula, and give it to your assistant, who already holds up the muscle with a spatula or hook. The second large cord, discovered by the separation of the first, is the artery: we look at it and feel it; it is very deep. Denude,¹ and charge it from behind forward, the left finger always lowering the posterior lip of the wound, and resting upon the vasculo-nervous bundle.²

If you wish to be sure of ligating the axillary

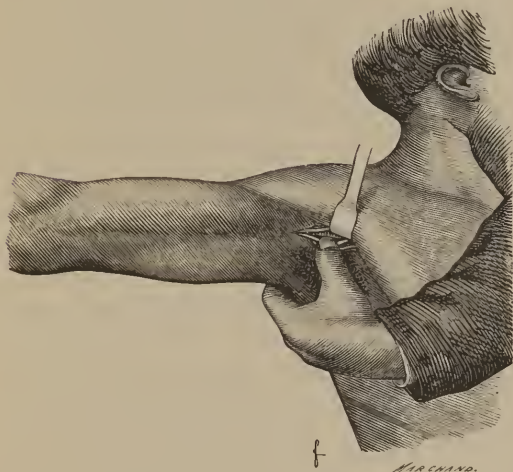
with the index-finger; but if on the right side, he operates above the shoulder, and can use only the thumb (see Fig. 25).

¹ When we have drawn out very far the finger which is thrust down into the wound and presses back the posterior lip and the nerves and veins, the small musculo-cutaneous nerve may present itself, but it is very small. Under the same circumstances, a vein may likewise present: it is sufficient to pinch it up between the two fingers to perceive that it is not the artery. The anticipated bifurcation of the artery is the only thing that can embarrass us.

² This artery is generally easy to isolate, and its collaterals easy to see, since it is naturally separated from its vein: this is why the canula generally suffices. If it is otherwise, the surgeon, having use for his left hand, will place a retractor over the veins and nerves situated in rear of the artery, and confide it to an assistant.

above the circumflex instead of the brachial, seek for the artery in the upper part of the wound.¹

FIG. 25.



Ligation of the axillary (*in the axilla*).—The incision being made, the coraco-brachialis muscle is recognized, then the first cord (median nerve); both are drawn forward by the retractor; the thumb of the left hand presses in rear the veins and nerves with the posterior lip of the wound, and discovers the second cord, which is the artery. For the left side, instead of operating over the shoulder and using the thumb, the surgeon places himself to the inside of the axilla, and draws down the lower lip of the wound with the index-finger.

¹ It is not rare to encounter a small supernumerary muscle stretched across the axilla, and which must be cut.

ARTICLE IV.

LIGATION OF THE AXILLARY ARTERY.

Beneath the clavicle.—The axillary artery, a continuation of the subclavian, originates at the *middle* of the clavicle. It soon gives off the acromio-thoracic, which in turn divides into numerous branches. The external side of the axillary artery touches the nerves of the brachial plexus; on its internal aspect it touches the axillary vein, which extends over upon it when it is full of blood (see Fig. 26, 2d).

The vasculo-nervous bundle is successively covered above and below, by the subclavian muscle (*s*); and by the aponeurosis of the pectoralis, so strong near the coracoid aponeurosis (*c*) that it merits the name of the internal coraco-clavicular ligament; by the pectoralis minor muscle, and by the continuation of the clavi-pectoral (*c'*) or coraco-clavi-axillary aponeurosis.

It is in the subclavicular triangle between the upper border of the pectoralis minor and subclavian muscles, and above the acromio-thoracic, that it is proper to ligate the artery.

The principal danger to be avoided is the *cephalic vein* (*b*), which, at first superficial, insinuates itself from below above, between the deltoid (*d*) and the pectoralis major (*a*), then, passing inward under this last muscle, attaches itself to the sheath of the subclavian, and, after a very short course, during which it crosses and re-covers the artery, perforates the clavi-pectoral aponeurosis, to empty into the axillary vein.

To reach the artery and spare the numerous acromio-thoracic arterial and venous branches, the venous canal formed by the convergence of the circumflex veins, the axillary vein, and the arch of the cephalic, it is necessary to push it below and inward ; and to do this we must open and detach the subclavian sheath, to which it is adherent.

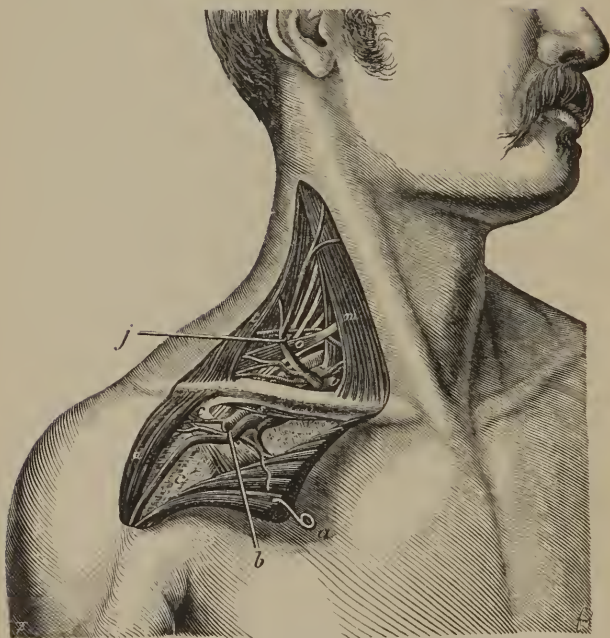
A very frequent anomaly renders this crowding back difficult : I refer to the case where the external jugular anastomoses with the cephalic by a vertical branch of variable volume, which passes in front of the clavicle, and may be recognized upon the living. In such a case it is necessary to cut this anastomosis between two ligatures, in order to render mobile the cephalic, or to run the risk of seeking for the artery under the arch of this vein.

The patient is laid upon his back on the border of the bed, with the shoulder out of the perpendicular. An assistant holds the arm a little drawn out from the trunk, and pushes the scapula back and above, in order to diminish the depth of the subclavian hollow.

The operator places himself a little outside of the arm,—near the body for the left side, and near the head for the right side.

After having recognized the sterno-clavicular articulation along the inferior border of the clavicle, feel for the coracoid apophysis, and the interstice of the pectoralis major and the deltoid, and the case becomes evident, revealing, if any, the anomalies of the cephalic vein.

FIG. 26.



The course and connections of the subclavian and axillary artery.—1st, *subclavian artery* in the subclavian region; *m*, cleido-mastoid muscle; *t*, trapezius muscle; *om*, omohyoid. The hook *j* draws outward the external jugular vein, which empties into *r*, the subclavian vein; it displays the exit of the artery outside the tendon of the scalenus anticus, below the nerves. Two horizontal arterioles run from within outwards, the one very near the clavicle, *a*, *subscapular*; the other higher up above the subclavian between the nerves, the *posterior scapular*, or *transverse cervical*. 2d, *axillary artery*, in the subclavian region; *d*, the deltoid muscle; *a*, hook drawing down the clavicular portion of the pectoralis major, cut on a level with its insertions, and revealing *c*, the coracoid apophysis, to which is attached the pectoralis minor; *c'*, the inferior preserved portion of the aponeurosis of this muscle, or the coraco-clavi-axillary aponeurosis; *b*, hook drawing down the arch of the *cephalic* vein detached from the subclavian muscle *s*, to which it adheres, in order to give a view of the artery which gives origin to the acromio-thoracic arterioles.

At a centimetre below the clavicle, and parallel to its curvature, make an incision in the skin of 0^m.08, commencing at two finger-breadths (0^m.04) outside of the sterno-clavicular articulation, and finishing near the coracoid apophysis, at the border of the deltoid, which is sometimes tangible and visible. Cut cautiously the cellular tissue in the external angle of the wound, where the cephalic vein dips downward. The lips of the skin being separated, the clavicle is revealed.¹ Cut immediately beneath the clavicular fascia of the pectoralis major; hold the bistoury straight and firm; touch the bone, but cut by making a number of small strokes. The fibres will retract, and soon plainly reveal the clavi-pectoral aponeurosis. Cut carefully upon the subclavian in the direction of its length, and very near the clavicle, the bistoury being inclined as if to graze the lower face of the bone and avoid the horizontal portion of the cephalic vein.² Then

¹ Although the muscle ought to be cut close,—grazing the clavicle,—the skin should be cut 0^m.01 below, for the platysma muscle will draw the upper lip even above the bone. It is true that after section of the pectoralis major the action of the platysma is counterbalanced.

² If after section of the pectoralis major we see that the horizontal portion of the cephalic is but slightly or not at all adherent to the subclavian, we may try to tear or cut the aponeurosis without opening the sheath of this muscle. In tearing it is proper not to separate more than a very little at a time, and assure ourselves of our progress as we go. In cutting,

press down the lower lip of the aponeurosis, tearing or separating it, if need be, in the external part of the incision, where it is very strong. Put the left finger down into the bottom of the wound. Run it along from one end to the other: the vein placed to the inside is thin and difficult of perception upon the cadaver; then we come to the artery, *broad and thick*, which is in reality the *first perceptible cord* found in searching from within outward; lastly, and very near to the artery, come the round cords of the brachial plexus; touch these, but do not isolate them. As soon as you know where the artery is, carry your finger above it and inward, to crowd back and protect the vein and its feeders, while the grooved director tears first the thin posterior wall of the sheath of the subclavian, and then the cellular sheath (Fig. 27); after which the artery-needle may be engaged within, under the artery. Now, loosening the vein, you will proceed with the finger to draw the nerves outward, and to receive the point of the needle.¹

it is best to use the director as is done in the operation for hernia, lifting up and cutting successively the aponeurotic layers.

¹ In denuding the artery, one may separate the vein and use the two hands in manipulating the instruments, but the finger, the advanced sentinel, sees better than the eye what passes at the bottom of a wound, and serves as a guide to the instruments. Furthermore, the two hands working thus together, if the left should happen to let slip the parts which

FIG. 27.



Ligation of the axillary (*beneath the clavicle*).—The shoulder is placed in a position backward and upward. The left index-finger, having perceived the artery and pushed the vein back to the inside, fixes and protects it. The point of the director tears open the sheath of the artery.

ARTICLE V.

LIGATION OF THE SUBCLAVIAN ARTERY.

Outside of the scaleni.—The course of proceeding necessary in this operation also permits the ligation *between* the scaleni. On the contrary, to place a ligature *inside the scaleni*, it is necessary to imitate the ligation of the *arteria innominata*.

have been drawn aside, the right, aware of it, immediately withdraws the instruments. No such connection can be established between the operator and the assistant using the retractor.

The subclavian artery originates very deeply, especially on the left side, to the inside of the scalene muscles. Ordinarily, it furnishes all its branches before emerging from the interval between these muscles. In the supra-clavicular depression, the arterial trunk is accessible and free from its collaterals. This, then, is the place of election for putting a ligature upon the vessel. At this level (Fig. 26), the artery rests *upon* the first rib, *immediately* to the outside and in rear of the tubercle of the internal border of this bone, to which descends the tendon of the scalenus anticus muscle, to become attached. The nerves proceed from the scaleni at different heights, but above the artery, which they do not approach until in the neighborhood of the clavicle. The vein (*v*) passing before the scalenus anticus is separated from the artery by the whole thickness of the muscle, and protected by the clavicle, but is enormous when full. It receives the *external jugular vein* (*j*), which crosses the artery and ought of necessity to be drawn either inward or outward—preferably outward, because of its affluents. Were it not for this vein endangering the operation, the artery would be easily reached between the trapezius (*t*) and the sterno-cleido-mastoid (*m*) (which one may cut slightly, if very large), above the clavicle, and the subscapular artery, which runs beside it, and is protected by it, beneath the omo-hyoid muscle (*o*) and the transverse cervical or posterior scapular artery, as it runs among the roots of the brachial plexus, but too high to be injured.

The tubercle of the scalenus is three finger-breadths ($0^m.05$ to $0^m.06$) from the sterno-clavicular articulation;

the jugular vein empties at somewhat more than a finger-breadth farther to the outside (0^m.07).

The internal border of the scalenus anticus, covered by the cleido-mastoid, is bordered by the phrenic nerve, which ought not to be forgotten when one resorts to cutting the external border of this muscle to ligate the artery *between* the scaleni.

The patient lies upon his back, with the neck extended, the head fully in the light, and the face turned to the sound side. A cushion elevates the chest, but the shoulder-blade of the affected side is turned out, to remain mobile. An assistant, acting upon the arm pressed closely to the trunk, lowers the shoulder, to diminish the depth of the supra-clavicular hollow.

The surgeon places himself near the head for the right, and near the body for the left side.

He recognizes the sterno-clavicular articulation and marks above the clavicle a point corresponding to the coracoid apophysis, follows with his fingers the upper border of the bone, and endeavors to compress the jugular vein where it empties into the subclavian, that he may see it swell up.¹

¹ The external jugular vein is always a great embarrassment (Ph. Bérard, *Dictionnaire* in 30 vols., t. iv. p. 504 and following): we may cut it between two ligatures, but we ought to endeavor to avoid resorting to so extreme a measure. It is for this reason that it is necessary to be assured in the beginning of the position of the vessel, and if possible to de-

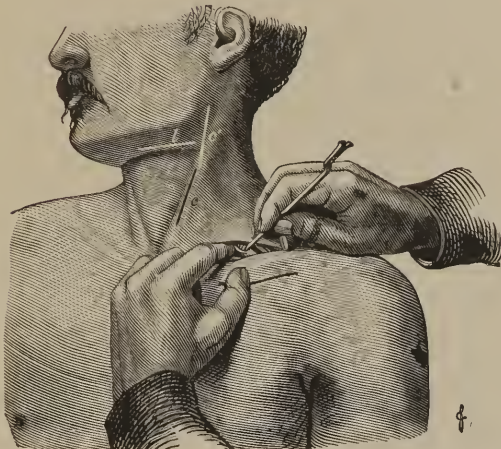
At the base of the supra-clavicular triangle, at a centimetre above the clavicle, and along its border, make an incision of 0^m.07, commencing at two finger-breadths from the sterno-clavicular articulation, and finishing at the point marked above the coracoid apophysis. Incise delicately the platysma myoides and the superficial aponeurosis. Cut as far as necessary the most external fibres of the cleido-mastoid: the lips of the wound separate, and expose to view the external jugular vein and its branches. Draw this outward (very rarely inward), and to do this loosen it by touching the bistoury to its internal border, which you will afterwards take up by a large blunt retractor. Try to carry the left index-finger down to the first rib, through the omo-clavicular aponeurosis, the ganglia, and the fat. Assist yourself, if you choose, by tearing the aponeurosis by forceps and director, working immediately above the clavicle, but being very careful while carrying the instruments in rear of the clavicle towards the subclavian vein. Finally, search with the finger for the *tendon* of the scalenus anticus, its *costal tubercle*, and immediately outward, *upon* the rib, touch and recognize the artery.¹ Leav-

termine beforehand how we are going to draw it, and make our incision a little more inward if the vein is to be drawn outward, or *vice versa*.

¹ We may say that the tendon of the scalenus anticus, tense and sharply defined on its edge as it is, is always easy to find.

ing the artery in place, bring the finger again upon the tubercle, touching it between the pulp

FIG. 28.



Ligation of the subclavian artery (*above the clavicle*).—The left index-finger, introduced into the internal angle of the wound, is *on* the tubercle of the anterior scalene muscle, and depresses the axillary vein. The artery is apparent, the sheath of which the right hand tears with the point of the director. The nerves pass into the external angle of the wound. The external jugular vein ought to be shown, drawn outward. *c*, incision for ligating the primitive carotid; *c'*, for the external or internal carotid; *l*, for the lingual.

and nail, your left hand being in pronation and the elbow away from the body (Fig. 28). Along

The tubercle is sometimes very small, almost imperceptible, and, furthermore, there is sometimes to the outer side and rear of the artery, at the insertion of the scalenus posticus, a projection sufficiently marked to put one on the wrong track. When we have found a tubercle, we should explore its environs, the depressible intervals of the scalenes, etc., and not stop at the first perceptible hardness.

the outer side of this finger¹ slip the director upon the vessel, rub it against it, and tear the cellular sheath, with the rib as the background of manipulation, in order not to pierce the pleura. With the finger standing guard over the tubercle, assure yourself again and again of the progress of the denudation by touching the artery. When this is perfectly perceptible and easily movable, proceed to take it up, with the point of the finger drawn inward towards the tubercle. Slip the eye of the curved artery-needle outward up to the rib, where you will rest it; slacken then the artery, which, on assuming its place, will charge itself. Push it a little, and, in order that the point of the instrument may disengage itself easily and without danger, guard it with the pulp of the finger.

ARTICLE VI.

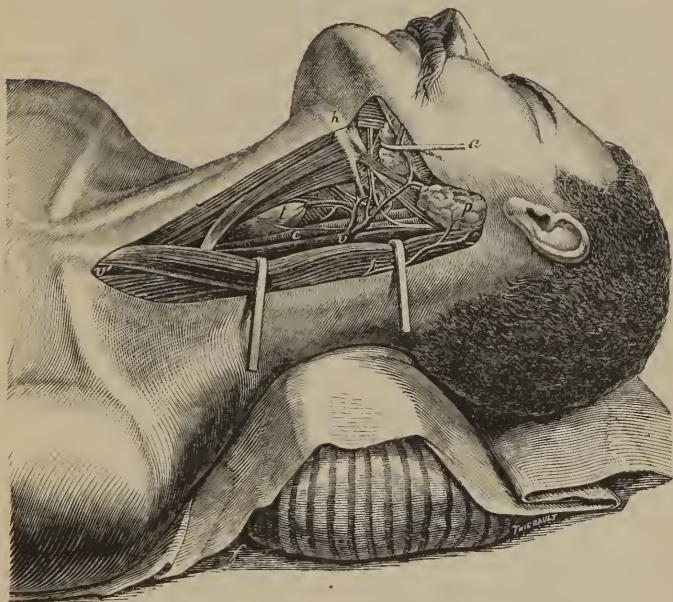
LIGATION OF THE CAROTID ARTERY.

§ 1. **Primitive carotid.**—This artery may be ligated at all points of its course, but with varying chances of success: the place of election is on a level with the thyroid cartilage, above the omo-hyoid muscle, some centimetres from

¹ The index-finger ought not to quit the tubercle, the landmark: its presence in the internal angle of the wound presses back and protects the subclavian vein.

its bifurcation. Farther on we will find the process appertaining to ligation of the inferior

FIG. 29.



Relations of the carotids, etc. (*the subject lying for the application of the ligature*).—Two hooks separate the sterno-mastoid muscle and external jugular vein, which is here attached to it, to show *v* the internal jugular and its confluent, the facial, lingual, pharyngeal, etc.; *c*, *primitive carotid* under *t*, the thyroid body; *v'*, the vein appearing between the heads of the sterno-mastoid; *p*, parotid; *h*, os hyoides. Under the parotid come out the digastric and stylo-hyoid muscles; still more deeply, the hypoglossal nerve crossing the carotids, of which the *external* anterior gives off the *thyroidean branch*, the *lingual*, and the *facial*; *a*, hook lifting up the submaxillary gland to reveal the subjacent parts (see Fig. 30).

extremity of the carotid (see ligation of the arteria innominata).

The primitive carotid lies in front of the transverse cervical apophyses, and to the inside of their anterior tubercles. That of the sixth is so salient, especially relatively to the apophysis of the seventh vertebra, which is obscured by the passage of the vertebral artery in front of it, that it constitutes a sure landmark, easy to discover (carotid tubercle of M. Chassaignac). It is situated 0^m.06 above the clavicle.

The *internal jugular vein*, adherent to the external side of the artery, encroaches over in front of it when it is full, and especially so at the lower part of the neck. Venous trunks, variable in number and volume, cross the artery to empty into the jugular: the most important receives the facial, lingual, and pharyngeal veins, etc., and ordinarily crosses the carotid artery near its bifurcation (Fig. 29, v).

Numerous ganglia surround the vessels and cover them when they become swollen; there are found furthermore, in front of the artery, filaments from the descending branch of the hypoglossal nerve. Behind the carotid descend the *pneumogastric nerve* adherent to its sheath, and the *great sympathetic*.

All these cords are crossed by the little omohyoid muscle, covered by its aponeurosis, and recovered by the anterior border of the sterno-cleido-mastoid. Down below, these vessels correspond with the interval between the heads of this muscle (v).

The patient will be laid upon his back, the

neck extended, and slightly elevated by a cushion; the head is first turned to the opposite side, then straightened out.

The surgeon explores the region, touches the depression separating the sterno-mastoid from the larynx, causes the subcutaneous veins, which are so frequently abnormal, to project; recognizes the thyroid cartilage, the os hyoides, etc.

Upon a line directed from the sterno-clavicular articulation to the parotid depression, upon the tangible and visible border of the sterno-cleido-mastoid muscle, make an incision in the skin 0^m.07 (four finger-breadths), starting from beneath the great horn of the os hyoides.¹ Incise the platysma and the aponeurosis on the *anterior border of the muscle* (first landmark). Isolate this border, detaching it carefully from its sheath with the point of the director, for the purpose of drawing it outward. Bring back the head into

¹ With this incision we ligate above the omo-hyoid muscle, which it is not necessary to cut; we tear very easily the aponeurosis, which seems to continue in the plane of this muscle higher up, and place the thread nearly on a level with the thyroid cartilage at 0^m.03 from the bifurcation (point of election) below the great venous trunk, which is almost constant, and fed from the face, the tongue, and the pharynx, and empties into the jugular, passing in front of the artery (Fig. 29, *v*). But in the amphithcatre, where subjects are always wanting, the pupil will, by preference, repeat the process indicated, so as to have an opportunity of ligating the external carotid, an operation, by the way, much resembling ligation of the primitive carotid at the place of election.

a straight position, carry the left index-finger into the wound and through the deep aponeurosis, seek the transverse apophyses, their *anterior tubercles*, and especially that of the sixth (second landmark), which is the last below, and the most salient.¹ You will perceive this tubercle very well through the vein, which last is enormously dilated in the living during expiration; immediately inwards you will find the artery, and on compressing it on the bone you may follow it up to the point where you wish to tie it. At this time, your finger, resting in the wound, pushes outward the two vessels yet ensheathed, and lets the artery go, which returns to its place, but retains and flattens out the vein, while you proceed, with the director near the larynx, prudently and by gentle strokes to tear through first the aponeurosis, then the sheath. If the vein escapes you, or if you suspect that it is about to do so, return to the artery, and bring back again to the outside all you can, except the artery itself.² Finally, when your finger

¹ When we keep the head turned to the opposite side the larynx is displaced, and the finger easily touches the anterior face of the vertebræ and perceives their rugosities, which may by an inattentive beginner be mistaken for the tubercles of the transverse apophyses.

² If necessary, the vein may be separated and protected by the fingers of an assistant or by a retractor, whilst the operator incises first the aponeurosis and then the cellular sheath: in this region, the less use one makes of the bistoury the better.

judges the denudation sufficient,—and it ought to be complete,—charge from without inward, with a Cooper's needle. Assure yourself, before ligating it, that the part elevated beats, and then flattens out perfectly,—that is to say, that you have the artery, and the artery only.¹

§ 2. **External and internal carotids.**—The process is the same for the two vessels, which are situated, like the primitive carotid, in front of the transverse apophyses, a landmark always easy to perceive. They are covered by the skin, platysma, a leaf-like aponeurosis, veins, ganglia, the cross-filament of the hypoglossal nerve, and some other nervous filaments. They are enlaced by some filaments of the great sympathetic, and cover its superior ganglion, the pneumogastric, and the origin of the superior laryngeal nerve. The sterno-mastoid muscle, which borders the primitive carotid in front, leaves the secondary carotids uncovered, and permits in the living the perception of the pulsations of these vessels in front of its anterior border, below the parotid, under which they bury themselves. When one wishes to discover the carotids he will frequently encounter two troublesome obstacles: 1st, above, the origin of the external jugular vein, which comes out from the lower part of the parotid, and frequently receives the facial, or an anastomosis pro-

¹ If the artery is badly denuded, we cannot slip the needle under it without violence, and at the risk of embracing the pneumogastric nerve in the ligature, a thing to be by all means avoided.

ceeding from this vein; 2d, below, the trunks of the facial, the linguals, the pharyngæals, the thyroidean or a common trunk (facio-lingual) receiving them all and emptying into the jugular vein, generally so low as to be capable of being drawn inwards or outwards when we ligate either of the carotids (see Figs. 29 and 30).

The great hypoglossal nerve, generally buried beneath the parotid, is sometimes useful and never troublesome to the operator. Nevertheless, I think, with M. Richet, that it is more difficult to find than the arteries themselves. I am sure that it does not always pass at the same distance from the bifurcation (varying so much as from 5 to 20 millimetres). Hence it cannot serve to determine precisely at what height to place the ligature.

The bifurcation of the primitive carotid takes place on a level with, or a little above, the large horn of the hyoid bone. The external carotid, from its position, deserves the name *anterior* carotid. When the head is turned, as is the case during the operation, it is really to the inside of the carotid which is called internal. This one furnishes no branch; the other gives off numerous branches, at varying heights. They are both crossed by the trunk of the hypoglossal nerve.

The first collateral furnished by the external carotid (superior thyroid artery) originates usually from the bifurcation; the second, ordinarily the lingual (we frequently see an inferior pharyngeal originate very low), detaches itself at a variable height. It is between these two branches that the ligature is generally

applied. This place of election is not so long as it is said to be, if I may rely upon the measurements I have made. In nine injected subjects, once only was it more than 0^m.01. (See Guyon, *Mém. de la Soc. de Chirurgie*, t. vi. p. 197).

In spite of the usual proximity of the collaterals, which one if he wishes can embrace in the ligature, or can ligate separately, the operation almost always succeeds (see GENERALITIES).

External carotid.—As in ligation of the primitive carotid, the patient lies upon his back, his neck elevated by a pillow, the head slightly turned in rear, and the face a little inclined to the sound side.

The surgeon explores the region, in order to ascertain the situation of the superficial veins, and to perceive the pulsations of the artery in front and to the inside of the relief of the sternomastoid.

In the track of the vessel, carefully make an incision of four finger-breadths (0^m.07), extending from a level with the middle of the thyroid cartilage to the parotid depression, *behind* the angle of the jaw (Fig. 28c'). Cut the platysma, and endeavor to spare and draw aside the external jugular vein, which you will encounter in the upper part of the wound, with the inferior lobes of the parotid. After having incised the superficial aponeurosis upon the border of the sterno-

mastoid muscle¹ and separated the fibres of this last in order to draw them outwards, separate the lips of the incision, and cleanse the wound, to see clearly the trunk of the facio-lingual vein. Seize the deep aponeurosis with the forceps; perforate it with the canula or point of the bistoury, and tear it cautiously, directing the instruments horizontally, as if to pass between the pharynx and the vertebral column.² Recognize and take care of the confluent, facial, lingual, and other veins, by drawing them down and forward.³ Then plunge the finger into the wound, inward towards the corner of the hyoid bone, in front of the transverse apophyses; touch and feel well the tubercles which terminate on their outside, and upon this osseous plane endeavor to compress the arteries, which you will perceive clearly,—at least if there are not numerous large ganglia, which in that case should be drawn aside. The

¹ It is better to cut the aponeurosis upon the muscle than in front of the muscle and upon the vessels, since the section is made then by two operations: 1, an incision without danger of the superficial fascia, on the muscular border; 2, a tearing, which is generally feasible, of the deep fascia. For the lower part, the sterno-mastoid is a very useful landmark.

² Pupils generally search beneath the sterno-mastoid, from before backwards, at the risk of wounding the internal jugular vein.

³ We ought, when drawing upon the arteries, to avoid the jugular vein, which should be kept outward by the assistant who draws aside the sterno-mastoid.

left index-finger, having found the carotids, recognizes the external one by its position (to the front and inside). It guides the director or forceps with which we tear the cellular tissue. Soon the operator can see a section of the great hypoglossal nerve, and the collateral arteries, and can complete the denudation at the place of election. The ligature is passed from without inwards, and is not to be tied until you are assured that the artery, on being lifted up, flattens out well, and that its compression arrests the circulation in the facial and superficial temporal arteries, which are easily explored.¹

ARTICLE VII.

LIGATION OF THE LINGUAL ARTERY.

This artery is accessible at two points in the sub-hyoidean region: 1, at a distance from its origin, above the tendon of the digastric; 2, near its origin, above the great cornu. Of the two different processes, the second only always per-

¹ It is evident that this process permits the ligation of the superior thyroid and internal carotid. The denudation of the artery ought to be made with care, and we ought to try and not embrace in the ligature the numerous sympathetic filaments which enlase it, since it is perhaps to the section of these vaso-motor filaments that the cerebral phenomena so frequently observed after ligation of this artery are to be attributed.

mits the ligation of the artery before the origin of the *dorsalis linguæ*, and, consequently, alone insures the checking of hemorrhage from the base of the tongue. This has been proved upon the living, which cannot be said for the first, which is, nevertheless, adopted by young surgeons, doubtless because of its great facility.

The lingual has its origin (*l*) on a level with the great cornu of the hyoid bone (*h*) or a little above it; it is covered by the facial, the superficial lingual, and the pharyngeal vein, and by the hypoglossal nerve, and in turn it covers the superior laryngeal nerve. Hence it is not very easy to isolate. But farther on, after having described a variable curve, the artery engages between the middle constrictor of the pharynx (*ph*) and the hyo-glossus, and disappears beneath the latter, while the great hypoglossal nerve, accompanied by a lingual vein, remains superficial. The artery and the vein, separated by the fibres of the hyo-glossus, proceed parallel, the one some millimetres above the other.

In the first part of their track they correspond to a depression or hollow, perceptible to the finger, formed by the great cornu and the posterior belly of the digastric muscle. Farther forward, the nerve passes beneath this muscle, joined to the stylo-glossus, and then forms with the digastric tendon and the posterior border of the mylo-hyoideus, under which it finally disappears, a *small triangle*, which covers the submaxillary gland (see Fig. 30). In revealing the lingual above the great cornu, one need only encounter

the veins already referred to, which may be easily drawn in rear.

To reveal it in the triangle, one is absolutely obliged

FIG. 30.



Relations of the external carotid and lingual arteries (*the subject lying ready for the ligation*).—M, the inferior border of the jaw; M', its angle; H, os hyoides; h, its great cornu; sh, sterno-hyoides; oh, omo-hyoides; h, thyro-hyoid; ph', inferior constrictor of the pharynx; ph, middle constrictor; d, posterior belly of the digastric perforating the stylo-hyoides; d', its pulley of reflection and tendon; hg, hyo-glossus; mh, mylo-hyoides; P, parotid gland covered by an aponeurotic expansion of the sterno-mastoid; smt, submaxillary gland drawn aside; je, external jugular; ji, internal jugular and its affluents, revealed by traction on the sterno-thyroid muscle; hyp, curve of the hypoglossal; ls, superior laryngeal nerve; cp, primitive carotid artery; ci, internal carotid; ce, external carotid; t, superior thyroid artery; l, lingual; f, facial; ** place of ligation of the lingual near its origin, between the great cornu and the hypoglossal nerve, *beneath* the hyo-glossus; *** place of ligation of the lingual artery away from its origin, in *its triangle*, always beneath the hyo-glossus muscle.

to open the bed or cell in which the gland lies, and draw this organ up. In both cases it is necessary to cut the hyo-glossus muscle, elevated with forceps, and not to go too deeply down into the pharynx or the tongue.

The os hyoides is sometimes situated very high up, or, if one choose so to express it, the submaxillary gland sometimes descends very low (in women), to such a degree as even to cover the great cornu and the hyoid bone. This being so, whichever proceeding we adopt, we are obliged to dissect the gland and draw it up above.

The patient is placed upon his back, the neck in full light, pressed down upon a pillow, and the head turned to one side.

The surgeon touches the region, and causes the external jugular vein to project out distended from its origin, following the os hyoides and its great cornu up to the border of the sterno-mastoid. During the operation, the hand of an assistant, on the neck, will maintain in position the os hyoides, which otherwise would escape from beneath the finger of the explorer.

§ 1. **In the triangle** (above the tendon of the digastric muscle).—At an equal distance from the os hyoides and the inferior border of the jaw, parallel to this border, make in the skin an incision of 0^m.04, which will terminate at a finger-breadth from the anterior border of the sterno-

mastoid.¹ Cut the platysma carefully in the posterior angle of the wound, where a facial vein passes;² near the inferior lip of the incision, which has now lowered and become concave, upon the inferior border of the gland, pinch, lift up, and then incise the aponeurosis. Recognize the gland, which is *now naked* (first landmark). Seize it with a hook, and draw it up while you separate its deep face from the subjacent parts.³ When the wound is well cleansed, and the dissection sufficient, you will perceive the *tendon of the digastric muscle* (second landmark), and the little triangle, veiled by the cellulo-fatty tissue; destroy this tissue, and recognize *the nerve* (third landmark) and the vein running along its inferior border. After having seized and fixed the digastric tendon, to hinder the movements of deglu-

¹ This incision is a finger-breadth from the maxillary border, and terminates just beneath the angle, but a finger-breadth below. We make the incision as convex below as the border of the gland, when this descends very low. In ordinary cases, the platysma, when there has not been an incision much out of a straight line, seems to have made it convex below, the inferior lip being strongly lowered by the fibres of this muscle.

² This vein is lodged in the partition which separates the parotid from the submaxillary gland; it is then necessary, especially after the opening of the cavity lodging the gland, to spare this partition.

³ The glandular bed ought to be opened, for if we make an incision below, in the hope of raising up the gland without denuding it, we run a strong risk of losing ourselves, after having had the misfortune to destroy the pulley of the digastric.

tition, pinch the hyo-glossus muscle, and, having lifted it up, make a delicate little nick parallel and subjacent to the nerve. The artery will soon present itself;¹ isolate it with the forceps, which tears its cellular sheath, and charge it with a curved artery-needle.

§ 2. **Above the great cornu.**—Very near to and above the os hyoides, parallel to its great cornu, make a rectilinear incision of 0^m.04, which touches the anterior border of the sterno-mastoid muscle. Cut the platysma cautiously, in the posterior angle of the wound, where the facial and jugular generally pass at their origin, and which you will draw up and in rear. With the finger, touch the projecting border of the gland and the horn of the os hyoides. If this is discovered, pinch up and incise the aponeurosis, immediately above, without denuding the gland, which you will hook upward, across its bed.² Then put the finger into the wound, above the *great cornu* (first landmark), and you will perceive the groove limiting above the posterior belly of the digastric,

¹ If we do not perceive the artery, it is because the nicking has been done either too high or too low: one ought then to draw up alternately each lip of the wound, and beneath either the one or the other he will find the vessel sought. The incision ought to be made two or three millimetres beneath the nerve.

² When the gland covers the great cornu, it is necessary to open its bed without hesitation, as in the preceding process.

where the *hypoglossal nerve* passes (second landmark), and where the artery beats. To see clearly, cleanse the wound, dissect a little, if necessary, at the same time taking care of the posterior angle, where numerous veinules pass, which a blunt hook draws aside and protects, and which, if wounded, would inundate you with blood. Hook up and make tense the great cornu, which would become displaced in the frequent movements of deglutition. The left hand, armed with a pair of forceps, then seizes the hyo-glossus muscle, delicately, in order to take up nothing but it. The right hand, armed with a bistoury, makes a slight nick in the muscle, subjacent to the nerve,¹ then, seizing a second forceps, aids the first in the denudation of the artery, which presents itself at the bottom of the little muscular wound.

¹ The little cut is parallel to the nerve and the great cornu, and perpendicular to the fibres of the muscle cut (hyo-glossus). It is best to make this prudently, and even to terminate it with the beak of the canula to save the artery intact and avoid entering the pharynx. If one could but see the posterior border of the hyo-glossus, he could slip underneath it the canula, or the blunt branch of a pair of curved seissors, and incise it without danger. But it is not proper to count on this, or even to desire it, since the more one operates in the rear, near the origin of the artery, the greater is the chance of wounding the veins, the pharynx, the superior laryngeal nerve, etc.; the more also does one expose himself to failure in finding the artery, which does not always come into or go out from its place beneath the great hypoglossal nerve in the same way.

ARTICLE VIII.

EXCEPTIONAL LIGATIONS.

I shall here describe briefly some operations which are only very rarely done : ligations of the *facial, temporal, occipital, arteria innominata*, and the *internal mammary*. The process described for the ligation of the external carotid permits the ligation of the superior thyroid artery. To find the vertebral artery, it is sufficient to discover the excellent landmark formed by the tubercle of the sixth cervical vertebra, by an incision analogous to that which one makes for ligation of the primitive carotid.

§ 1. **Ligation of the facial artery.**—One may ligate the facial at its origin, as he may all the branches which the external carotid furnishes, by searching first for this artery. M. Duval has been able to ligate it, in the first part of its track, by an incision curvilinear like the artery itself. But one will hardly ligate this vessel until the moment when, disengaging itself from beneath the submaxillary gland, it enters the facial region, passing beneath the inferior border of the jaw, in the perceptible depression situated in front of the anterior border of the masseter, 0^m.03 from the angle. At this point the artery is accompanied by a vein, which follows its posterior border.

After having recognized the pulsations of the artery, and the ante-masseteric depression, very

marked when the patient closes his teeth, we make a horizontal incision of 0^m.03, crossing the vessel, and consequently in the direction of the border of the jaw. We cut carefully the platysma, and explore the wound with the end of the finger. The artery gives the sensation of a thick cord, which pulsates and is displaced easily. We isolate it, and try to spare the vein placed in the rear.

§ 2. **Ligation of the temporal artery.**—If we are obliged to tie the temporal artery, we will seek it at the point where, going out from beneath the parotid, it is reflected beneath the long pillar of the zygomatic arch, in rear of the condyle of the jaw, just in the angle forming these two parts.

The temporal never becomes very superficial immediately after its proceeding from the parotid. In the first part of its track of ascent its pulsations are very difficult to perceive. With the least swelling of the region, they become incapable of serving as a guide to trace the incision.

Between the tragus and the condyle make a vertical incision of 0^m.03, cutting the zygomatic in two at its root. You will probably encounter a small pre-auricular ganglion, the temporal vein; and in front of this, but deeper, your finger will perceive the artery, beneath the root of the zygoma, and touching the condyle. It would be better to denude with care, rather than to

embrace in a curved needle, which has grazed the periosteum, the artery, the vein, and even the auriculo-temporal nerve.

§ 3. **Ligation of the occipital artery.**—We make a nearly horizontal incision, commencing at the point of the mastoid apophysis, and prolonging it to 0^m.05 in rear and a little above. We cut the posterior border of the sterno-cleido-mastoid and its aponeurosis, then the splenius, and finally the small complexus.¹ This done, the index-finger, plunged into the anterior angle of the wound, searches for the mastoid apophysis, and above the transverse apophysis of the atlas; between the two passes the artery, attached to the posterior belly of the digastric, between this and the superior oblique.²

§ 4. **Ligation of the arteria innominata and the primitive carotids and subclavians near their origin.**—These difficult, disastrous, and exceptional ligations can be made by the same process. The vessels which have to be sought are situated deep in the medias-

¹ After having cut the splenius, it is not absolutely necessary to cut the small complexus. One may indeed find the artery, by searching diligently for it, at a finger-breadth beneath and in rear of the *tangible* rugosities of the posterior border of the mastoid apophysis. Exceptionally it happens that the occipital artery rests even more superficially than the small complexus.

² The occipital vein, receiving at this point large mastoid-ean branches, ought to be manipulated as carefully as possible.

tinum, in the neighborhood of the pleura, surrounded by important organs, nerves, the thoracic canal, etc., masked by the veins, which become enormous at each movement of expiration. Besides, in case of the apparent success of the operation, the solid obliteration of the two ends can scarcely be counted upon.

In reaching the vessels one is greatly hindered by the sternum (M. Chassaignac thought it absurd not to resect it), and also by the trunks of the jugular and innominata veins, as they proceed to empty themselves, and which cannot be drawn away, except to the outside and below. The internal or tracheal side is the only one accessible; still, it is necessary to avoid the thyroid veins, which are sometimes enormous. Hence it is from within and without that we must reach the arteria innominata, and the carotids and subclavians at their origin. Therefore the surgeon may place himself on either side of his patient indifferently.

He will easily find the carotid, thanks to the landmark furnished by the tubercle of the sixth vertebra, accessible in the culminating part of the incision, and can, by following the vessel, arrive at its origin, on the trunk of the arteria innominata and the left subclavian. On the left side, after having followed the carotid below, and having lightly drawn it outward, he can perceive it with the finger, and compress the subclavian upon the transverse apophysis of the seventh vertebra, and upon the head of the first rib.

On both sides the trachea, so easy to perceive, is a good landmark. The innominate trunk is in front. It bifurcates in rear of the sterno-clavicular articulation,

from which it is separated by the thickness of the right venous trunk, which we succeed in keeping outside, if we do not, indeed, have at the same time to do as much for the great anterior jugular or thyroid. When necessary, we can cut these veins between two ligatures. To ligate the innominate trunk at its middle it is necessary to have the left venous trunk previously drawn down and to the left.

The innominate trunk.—The patient is placed as if the operator were about to ligate the carotid artery.

Upon the sterno-cleido-mastoideus, at least 0^m.06 above the clavicle, commence an incision which descends in the interspace between the heads of this muscle clear to the bone, and then curves horizontally within up even to the median line, simulating an obtuse angle. Cut the sternal fascia of the muscle near its insertions, upon the director, carefully. Separate the clavicular fascia, and draw it inward by means of an assistant, who draws aside the internal or convex lip of the wound. Near this lip and the *trachea* (the landmark), off from the jugular vein, incise upon a director the most external fibres of the sterno-hyoideus and sterno-thyroideus muscles. Give them to an assistant, who will draw them inward with a large retractor. Incise also, or, better, tear, a deep aponeurotic fascia, in which are the thyroid veins, and then draw these veins inward. Plunge the finger into the extremity of the incision, and search for the carotid tubercle and the

carotid artery; then descend, following this vessel as low as possible. The innominate trunk is in rear of and far from the sternum, and in front of and close to the trachea. With a second finger in the wound, if you are placed on the side operated upon (with a retractor held by an assistant in the opposite case), separate and protect the venous trunks, whilst the index-finger seeks to isolate the arterial trunk, and serves as a guide to a long pair of forceps, which are used to tear little by little the cellular sheath. Pass a curved needle from without inwards, and ligate the vessel, if you can, at an equal distance from its origin and its termination; that is to say, very deeply.

§ 5. Ligation of the internal mammary.—

This artery descends in rear of the costal cartilages, and is accessible only in their intervals,—that is to say, beneath the skin, the great pectoral, the aponeurosis of the external intercostal muscle, and finally the fibres of the internal intercostal. It makes its way in the sub-pleural tissue loosely and is easy to tear; it is accompanied by one chief vein situated to the inside and easy to isolate. We will find it about 0^m.01 from the external border of the sternum.

In one of the first three or four intercostal spaces, make a transverse incision of 0^m.04 in length, which encroaches upon the external bor-

der of the sternum. Separate the fibres of the pectoralis major with the bistoury, and denude the border of the bone and the intercostal aponeurosis; also carefully cut the fibres beneath (with a probe-pointed bistoury).¹ So long as the finger plunged in the wound perceives the resistance of the fibres, there is no danger, for it is not yet upon the pleura. Finally, denude with two forceps, which will easily tear the cellular tissue.

¹ When one operates in this region, which, like the abdomen, may be suddenly heaved up by thoracic effort, the hand which holds the bistoury ought to support itself upon the patient, in order to follow *forcibly* all the movements of the plane on which the incision is made.

CHAPTER II.

LIGATION OF ARTERIES OF THE INFERIOR AORTIC SYSTEM.

ARTICLE I.

LIGATION OF THE DORSALIS PEDIS.

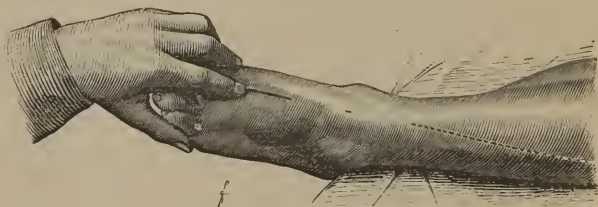
WHEN this artery is normal, it is a continuation of the anterior tibial, which, on a level with the annular ligament, passes beneath the extensor of the great toe, bears inward, and reappears beneath the skin of the back of the foot, under the name of the *dorsalis pedis*. It is soon bordered by the internal fascia of the extensor *brevis digitorum*, which at first covers it, and, in its turn, soon passes within, at the moment the artery terminates, by piercing the first dorsal interosseous muscle, to gain the sole of the foot. From this disposition it results that the vessel is accessible either upon the back of the foot, *within* the extensor *brevis*, or near the posterior extremity of the first inter-metatarsal space, *outside* of the first tendon of the extensor *brevis*. At this point one is always sure to encounter the artery, whether it be normal or abnormal. In the last case the artery generally follows the interosseous course, and goes under the body of the extensor *brevis digito-*

rum, from without inward. In case of an anomaly, the ordinary place of the *dorsalis pedis* artery is always occupied by an arteriole and two veinules. We cannot reach the artery with which we are concerned without tearing through many resisting aponeurotic coverings, and drawing aside many nervous filaments.

The patient lies upon his back, with the limb extended.

The operator, placing himself to the outside, searches for the posterior extremity of the first inter-metatarsal space (Fig. 31), and traces a line starting from this point and coming out at the middle of the instep.

FIG. 31.



Ligation of the *dorsalis pedis*.—The left index-finger seeks for the posterior extremity of the first inter-metatarsal space, and here rests. A part of the incision is directed towards the middle of the marked inter-malleolar space. It lies 0m.01 from the side of the *extensor communis* tendon, which is seen in relief.

Upon the line indicated, starting from the posterior extremity of the first inter-metatarsal space (where it terminates, or not, according to the side), make upon the tarsus an incision of

0^m.04, parallel to the visible tendon of the long extensor of the great toe, but about 0^m.01 to the outside of this tendon. In cutting the cellular tissue, avoid the veins and nerves. Try to feel or see the internal fascia of the extensor brevis, and incise the aponeurosis above; recognize the fibres of this muscle.¹ Its internal border being carefully drawn outward, you will expose the artery and its veins to view or to the touch. If not, search the metatarsal extremity of the wound, but to the outside of the tendon of the extensor brevis digitorum; the abnormal artery will certainly pass here.

ARTICLE II.

LIGATION OF THE ANTERIOR TIBIAL ARTERY.

This artery is accompanied by two veins and a small nerve placed in front, running alongside the external border of the tibialis anticus muscle. Above, it is in the bottom of the single interstice of the anterior tibial region; below, in the most internal of the two interstices, between the tibialis and the extensor proprius pollicis. Above, the tibialis anticus is very large, and the extensor of the toes very narrow. A strong aponeurotic partition separates this last from the pero-

¹ The incision indicated corresponds to the junction of the muscular fibres and the tendon; one finds the former in the posterior extremity of the wound, and the latter in the anterior extremity. It can serve for the ligation of either the normal or the abnormal artery.

neus brevis; and if one is guided exclusively by the longitudinal depression which he can perceive, even beneath the skin, pretty near the track of the artery, he will penetrate in front of this partition, between it and the extensor communis muscle, the fibres of which he will afterwards be compelled to cut, in order to get within upon the vessels. Following Bell, S. Cooper formerly recommended this course, doubtless because of the difficulty he had experienced in finding the proper interstices.

Though very deep down where it first comes upon the interosseous ligament, the anterior tibial artery becomes more superficial towards the instep, where it passes through the middle of the malleolar interspace. To determine this passage, it is necessary to place one's self in front of the limb, and, putting a finger upon each malleolus, mark the middle point of a line drawn between them.

If we know how to find the anterior tibial at its superior and its inferior part, we shall have no difficulty in finding it in the middle of the limb. I have, then, but two operations to describe: 1st, ligation above the annular ligament; 2d, ligation of the superior part.

To trace the *line of operation*, search for the head of the tibia and the *depression* which is in front, between it and the tubercle of the fascia lata, or tubercle of Gerdy;¹ from this *anteperoneal* depres-

¹ To take this tubercle as the landmark in the operation, is to forget the large size of the tibialis anticus, and to expose

sion draw a straight line, which comes out on the middle of the instep, in front, to the outer side of the projection of the tendon of the *tibialis anticus*, which is perceptible to both eye and finger.

The patient is laid upon his back, the limb straightened out, and turned inwards. An assistant holds the foot, ready to flex it as needed.

The operator places himself to the outer side of the limb.

§ 1. **Above the annular ligament.**—Upon the line indicated, commencing or finishing (according to the side) at two finger-breadths above the articulation, make on the skin, and then through the aponeurosis, an incision extending to 0^m.06, or more. Lift up with the grooved director the internal lip of the aponeurosis, feel beneath with the index-finger, and carry it upon the crest of the tibia, without crowding away anything¹ (see Fig. 32). Then bring the finger gently outward, slightly catching the tendons: let a single tendon escape inward, and do not move farther.² You are in the proper interstice; open it from below upward, with the

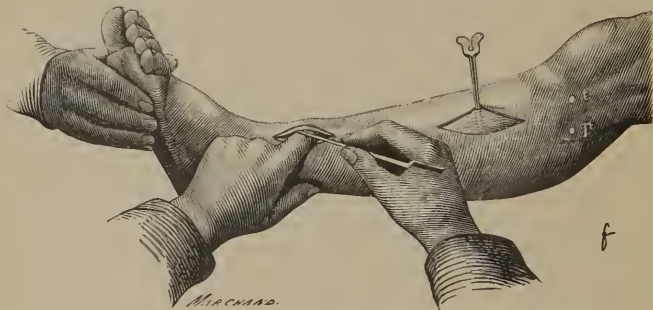
one's self to the risk of falling upon this musele very far within the line of the interstice sought for.

¹ Assure yourself with the right hand that the tendon of the *tibialis* has not been crowded back by the left finger.

² The extensor tendon of the great toe glides easily along with that of the *tibialis anticus*.

grooved director. The foot being then flexed, the borders of the wound are easily separated; and within, close against the external face of the tibialis anticus, which is thin at this level, or

FIG. 32.



Ligation of the anterior tibial artery (*at the inferior part*).—An assistant holds the foot, and flexes it. The operator has lifted up the internal lip of the aponeurosis with the grooved director; he glides his finger above, and goes to the crest of the tibia. After assuring himself that he has crowded back nothing, he brings back his index-finger to the outer side, and lets a single tendon escape inward.

There is to be seen a director slid across beneath the aponeurosis of the tibialis anticus (at its upper part); its point has been arrested by the partition which separates the peroneus longus from the extensor communis. In cutting upon the director, one is then sure to cross the interstice at the bottom of which lies the artery.

upon the bone itself, you will find the artery between its two veins. The vascular bundle is a little deep, but very mobile, so that it will be necessary to fix it, by pinching up the cellular sheath to isolate the artery with the canula.

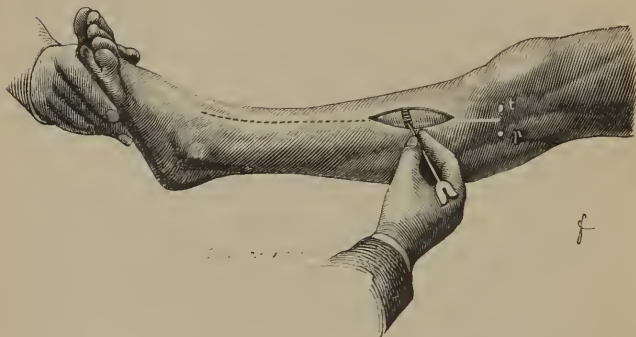
§ 2. **At the superior part of the leg.**¹—Upon the line indicated make an incision of 0^m.08 (at the least) through skin and cellular tissue, down to the aponeurosis *only*. With the thumb and left index-finger separate equally the two lips of the wound, and in the middle incise the aponeurosis *transversely*, without entering the muscles.² Explore this incision from within outwards with the point of the left finger and the beak of the grooved director, observing closely (see Fig. 33). You will find, *far* from the crest of the tibia, a first interstice, but slightly perceptible, sometimes fatty, and deprived of its aponeurotic partition. At some millimetres outside you will find a second, which the finger easily perceives, even through the aponeurosis; it is occupied by a strong partition, which resists and vibrates under the point of the grooved director. Return to the first, which is the proper one.

¹ This operation is the more difficult in proportion as it is done higher up. The incision will therefore be made as low as possible, and its superior extremity will always rest at least three finger-breadths below the articulation.

² A good course to pursue is the following: After having drawn the internal lip of the skin over towards the crest of the tibia, perforate the aponeurosis with the point of the director, which is then to be slid beneath it, crossways, from within outwards, until there is perceived the resistance furnished by the aponeurotic partition which separates the common extensor from the peroneals. We incise the fibrous covering, and this incision certainly crossing the interstice sought for, it is easily found (see Fig. 32).

Above and below the transverse incision cut the aponeurosis¹ upon this interstice, and open

FIG. 33.



Ligation of the anterior tibial (*upper part*).—After section of the skin, a transverse incision has been made. The director, following the eye, and the finger (which intervenes from time to time), explore this from within outward, and, far from the crest of the tibia, is arrested upon the first interstice, easy to open and to be deprived of its aponeurotic partition; or, rather, go to the second, and recognize the partition which vibrates under the instrument, to return again to the first.

it delicately with the finger from below above, causing the foot to be flexed.² You will at first

¹ When we try to ligate the tibial by the classical process, we first cut the aponeurosis lengthwise, and then crosswise, since the lips will not separate without this. In commencing by the longitudinal incision, there is a risk of failure to find the interstice, which is ordinarily invisible. On the contrary, the transverse incision being made first renders it certain, and permits a recognition and slitting-up of the aponeurosis just above it.

² Like the transverse section of the aponeurosis, the object of flexion of the foot is the permitting of the separation

encounter a small isolated nerve; then, at the bottom, the artery and its two veins. For denuding and charging the vessel, an assistant buries his thumbs deeply in the extremities of the wound, and, causing it to gape largely, gives access to light and to the instruments. A slightly-curved needle is indispensable.

ARTICLE III.

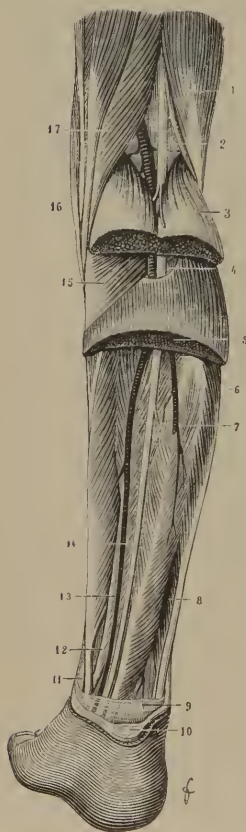
LIGATION OF THE POSTERIOR ARTERIES OF THE LIMB.

The posterior tibial and peroneal arteries are attached by an aponeurosis in rear of the deep layer of muscles of the limb. The large posterior tibial nerve is situated between the two, and upon the same plane (Fig. 34).

The *peroneal artery*, generally the smallest, ordinarily disappears on penetrating the subjacent muscle (the flexor proprius pollicis), and, consequently, ought not to be sought for, excepting on a level with the calf. On the contrary, the *posterior tibial artery* descends without any notable diminution of volume, and passes in rear of the internal malleolus, with its corresponding nerve, which is connected with it, to go to the sole of the foot. At this level it is no longer in connection with the deep muscles, but with their tendons ;

of the walls of the deep gutter, at the bottom of which rests the artery. This separation is not sufficient without the aid of the two thumbs of the assistant, or, better still, of retractors as broad as the wound is long.

FIG. 34.



The track of the posterior tibial artery, with its relations to the limb.—1, biceps; 2, sciatic and popliteal nerve, and *popliteal artery*; 3, superior extremities of the gastrocnemius cut across; 4, posterior tibial nerve and *popliteal artery* passing through the ring of the soleus muscle; 5, soleus cut across; 6, peroneus longus muscle; 7, flexor proprius pollicis muscle, and *peroneal artery* penetrating it below; 8, peroneus brevis; 9, deep aponeurosis, enveloping tendons, nerves, and vessels in rear of the bone of the leg; 10, tendon of Achilles, enveloped by the superficial aponeurosis; 11, tendon of the flexor communis digitorum; 12, tendon of the tibialis posticus; 13, posterior tibial artery; 14, posterior tibial nerve; 15, popliteus muscle; 16, tendons of the sartorius, semi-tendinous, and semi-membranous muscles; 17, semi-membranous muscle.

parallel with it, the superficial muscular bed, so large and thick, which covers it on a level with the calf, is now only represented by the tendo Achillis, and, con-

sequently, the two aponeuroses, the superficial and profound, have become easily accessible.

The two posterior arteries of the limb are accompanied each by two veins, often enormous, and very troublesome for denudation. Often, also, in incising the soleus, we encounter the intra-muscular veins, which inundate the wound with blood.

Nothing is easier upon the cadaver than the discovery of the vessels which occupy us: it is sufficient to incise the muscles of the calf upon the median line. We will soon reach the nerve, on the sides of which are the vascular bundles. Messrs. Arnold and Guthrie recommend this mode, according to Holmes (*System of Surgery*); Malgaigne engaged to search for the popliteal artery, and the origin of its branches, in an analogous manner, confining himself to a separation of the fibres of the gastrocnemius muscle. But it was necessary for him to sacrifice the arteries and companion veins, which seems to me not a small inconvenience, because of the trouble liable to occur from hemorrhage.

Generally we operate from each side, separating the side of the gastrocnemius corresponding, and only cutting the soleus; but reaching the bottom of the wound, we can only ligate one artery, which would be embarrassing if, in a case of hemorrhage of doubtful origin, it should happen that the artery which did not furnish the blood should prove to be the one sought for.

A. LIGATION OF THE POSTERIOR TIBIAL ARTERY.

The process we shall first describe permits, with slight modifications, the ligation to be done throughout all the lower half of the limb.

§ 1. **In rear of the malleolus.**—The patient is laid upon his back, and turned a little towards the side to be operated upon; the limb, being flexed, rests upon its external face.

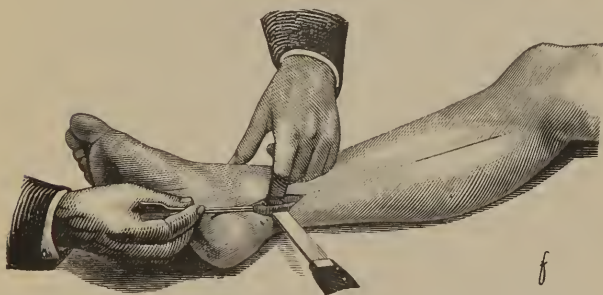
The surgeon, placing himself to the outside, explores the retro-malleolar groove, the anterior osseous lip, and the posterior, with the border of the tendo Achillis.

In the middle of the retro-malleolar depression, at a finger-breadth in rear of the posterior border of the malleolus and parallel to this border, make a cutaneous incision of 0^m.05, which shall descend to a level with the point of the malleolus.¹ Put the finger in the wound, and, the foot being flexed, touch the superficial aponeurosis, which overlies the tendo Achillis. Make a direct incision of this aponeurosis, near the

¹ Many surgeons, Velpeau, M. Richet, and others, recommend a curvilinear incision including the posterior border and summit of the malleolus in its concavity, but avoiding the sheath of the tendons. In this manner one will find the artery after having cut the internal annular ligament, which is formed by the fusion of the two aponeuroses which are distinct a little higher up.

tendo Achillis.¹ Replace the finger in the wound, first upon the malleolar border, then upon the tendons, perceptible through their sheaths; then move to the outside: the artery sought will be found pulsating. Draw aside the tendo Achillis, and keep the finger upon the sheath of the tendons, for their protection, while you introduce

FIG. 35.



Ligation of the posterior tibial (*in rear of the malleolus*).—The limb, with the calf relaxed, is lying upon its external face. After the incision of the superficial aponeurosis, and the drawing aside of the tendo Achillis, the left index-finger touches the posterior border of the malleolus, then the tendons through their sheath, which covers and protects them. Outside of this sheath the director is slipped beneath the deep aponeurosis.

the director to the outside, beneath the deep aponeurosis which covers the vasculo-nervous

¹ When this aponeurosis is cut, the finger can bury itself between the tendo Achillis and the bone of the limb; and one is tempted to operate in this depression, right or wrong, if he forgets the true situation of the artery, which can only be seen by lowering his head, after attacking the deep aponeurosis from behind forward.

bundle (see Fig. 35). The aponeurosis being cut, you will find the artery, its two veins, and the large nerve to the outer side. Denude with the grooved director and pinch up, since the vessels are very mobile. Charge from without inwards.

§ 2. **On a level with the calf.**—The patient is laid upon the side which is to be operated upon; the flexed limb is laid upon its external face. The knee and the calf, drawn up to the edge of the bed, are presented flexed for the operator.

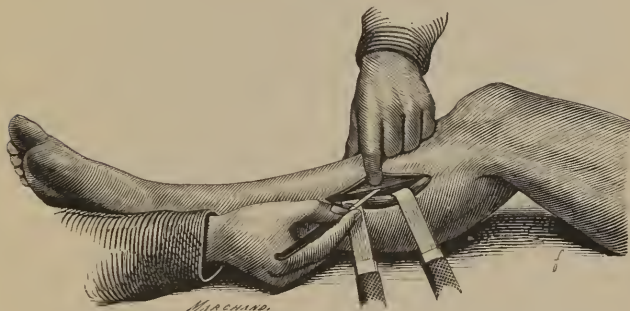
The surgeon, placed to the outside, explores the region and the track of the veins; he touches the internal border of the tibia, and the internal border of the gastrocnemius while in a state of contraction.

At a finger-breadth in rear of the tibia, parallel to its internal border, below the level of the ham, make an incision of 0^m.10. Cut the aponeurosis along the internal border of the gastrocnemius (first landmark). Recognize this, isolate it, and cause it to recede outwards; that is to say, lower it by two retractors.¹ Stoop down and look at the posterior face of the soleus, which it is necessary to incise. For attacking this muscle perpendicularly to its surface,

¹ It is to permit this separation that the calf should be relaxed by the limb being flexed. This greatly facilitates the rest of the operation.

hold the bistoury *horizontally*, and make an incision from one end of the wound to the other, as far as possible from the internal border of the tibia¹ (Fig. 36). But incise it by a number of small

FIG. 36.



Ligation of the posterior tibial artery (on a level with the calf).—The limb is slightly flexed, and turned upon its external face. The internal face of the gastrocnemius is easily drawn outward, when the knee is caused to project forward. The left finger draws upon the anterior lip of the wound; the bistoury attacks the soleus perpendicularly to its surface.

strokes. At each stroke of the bistoury, the assistant, armed with his two retractors, buries them in the wound to lower the external lip, at the same time that the left finger of the operator draws to him the internal lip. The way open, you will encounter the *intramuscular aponeurosis* of the

¹ It is necessary to incise the muscle perpendicularly to arrive at the artery by the shortest route, and which is at some distance from the internal border of the tibia (0^m.03), to fall just upon the vessels corresponding to the external border of the bone.

soleus (second landmark); recognize it, and remember that there are few or no muscular fibres beneath.¹ Cut this delicately, or tear it if you can. If there are fibres beneath, tear them carefully with the director. The lips of the muscle, now cut in two, separate, and expose to sight and touch the vessels sought for, and the nerve to the inner side of which they are placed. Tear the deep aponeurosis over the artery to a slight extent, and as near as possible in the interval between two of the transverse venous anastomoses; pass the curved needle from without inwards.

B. LIGATION OF THE PERONEAL ARTERY.

On a level with the calf.—The patient is laid upon the sound side, nearly on his belly. The limb, slightly flexed, reposes upon the antero-internal face.

For the rest, this operation resembles the ligation of the posterior tibial on a level with the calf. The surgeon, placing himself to the outer

¹ If one forgets that generally there are no muscular fibres under this aponeurosis, he risks, in making the incision too boldly, either splitting the vessels, or falling too much to the inside and entering directly and losing himself within the flexor communis: this is to be feared when upon a varicose limb the sub-muscular tissue has become lardaceous and does not permit the lips of the soleus to glide easily.

side of the patient, explores the region, following the posterior border of the fibula and the external border of the gastrocnemius during its contraction.

At a wide finger-breadth in rear of the fibula, and parallel to this bone, upon the external border of the gastrocnemius and below the ham, make an incision of the skin 0^m.10 in length. Cut the aponeurosis the length of the external border of the gastrocnemius (first landmark); recognize and isolate this border, and draw it inward by two retractors. Incise the soleus perpendicularly to its surface, from one extremity of the wound to the other, so as to fall upon the internal border of the fibula. Incise layer by layer, and at each incision of the bistoury cause a separation of the borders of the wound, in order to recognize clearly the *intramuscular aponeurosis* of the soleus (second landmark). Cut this delicately, and more delicately still the muscular fibres which are underneath. Very soon the lips of the muscle, now totally divided, separate, and expose to sight or to touch the vessels sought for, and the nerve to the inner side. Tear the deep aponeurosis to a slight extent, and immediately over the artery, and as near as possible immediately between two transverse venous anastomoses; pass the curved artery-needle from within outwards.

ARTICLE IV.

LIGATION OF THE POPLITEAL ARTERY

In the popliteal space.—After having perforated the adductor magnus, and given off the anastomotica magna, the femoral artery, with its vein, passes in rear of the femur, to which it is applied, and proceeds to the inferior angle of the popliteal space, approaching by degrees the internal popliteal branch of the sciatic nerve, along with which it disappears beneath the gastrocnemius muscle, on a level with the line of the articulation. The popliteal artery furnishes numerous anastomotic articular branches with the anastomotica magna, and lies very deep; its vein covers it, and generally projects beyond the outside of it. As to the nerve, it is more external, and also much more superficial, than the two vessels (see Fig. 34).

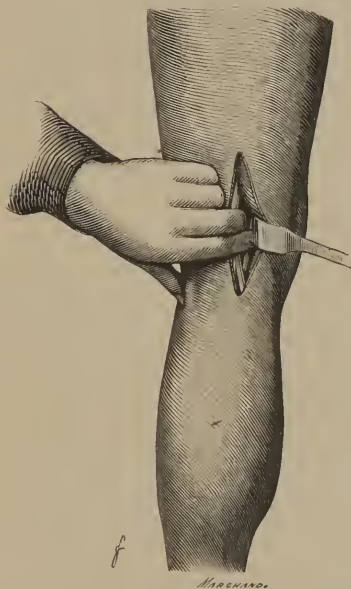
The patient will be laid upon his belly, and the limb first extended and afterwards flexed.

The operator places himself to the outer side, bends the leg on the thigh, and marks the fold; then he feels for the popliteal hollow, behind the lower extremity of the thigh. He also searches for the external saphenous vein.

In the axis of the popliteal depression make an incision of the skin of 0^m.10, which descends to a level with the fold of the ham. In cutting the aponeurosis, avoid the external saphenous

vein at its mouth or origin. Put the index-finger in the wound, and try to perceive the stretched

FIG. 37.



Ligation of the popliteal artery.—The subject is placed on his belly. Two fingers of the left hand are in the wound; the middle finger holding and separating the nerve, the index-finger searches for and detects the vein and artery within upon the femur.

and superficial nerve. Do not denude it, but pass the director to the inside and tear the cellular tissue. Cause the internal lip and the semi-membranous muscle to be separated by flexing and relaxing; draw the nerve out with your

middle finger, and proceed with the index-finger to search for the vascular cord, thick and profound (Fig. 37). When this cord is found, attack its internal side with the point of the director, which gradually reaches the cellular sheath and tears it, permitting the finger, which has followed the progress of the denudation, to draw the vein outwards. At this moment a curved artery-needle is slid down upon the index-finger and passed under the artery from without inwards.

ARTICLE V.

LIGATION OF THE FEMORAL ARTERY.

The femoral artery makes its exit from the abdomen beneath the middle of the crural arch (a little within the exact middle line). It is at first subaponeurotic, in the triangle of Scarpa; then the *sartorius muscle* borders upon it, and soon after covers it completely.

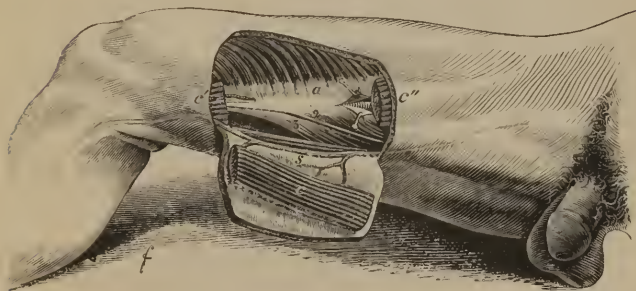
This artery, perceptible to eye and touch, runs over the great groove formed on the one side by the plane of the adductors, and on the other and outer side by the projecting cylindroid of the *psoas* above and the *vastus internus* lower down.

The artery perforates the plane of the adductors, to pass in rear of the ham, four finger-breadths below the internal condyle of the femur. Before thus perforating the adductor magnus, it is lodged in the angular groove formed by this muscle and the *vastus internus*. This groove is straight; its internal lip (the tendon of the adductor) is easy to perceive when stretched by

abduction. It is in reality a prismatic triangular canal (*the canal of Hunter*), for an aponeurotic covering, attached to the two lips of this groove, is stretched like a band (of a finger-breadth) in front of the vessels, from the ring of the adductor up to 0^m.10 above, where it ceases to be composed of resisting fibres, and insensibly becomes cellular.

The *primitive femoral artery*, after having furnished

FIG. 38.



The canal of Hunter (*in the position in which the member ought to be placed to ligate the femoral artery at this level*).—A flap, comprising the skin and sartorius *c*, has been cut and drawn back to show the canal; at the base is seen the saphenous vein *s*, which borders the gracilis. *c'* and *c''* are the two cut ends of the sartorius; *a*, the vastus internus muscle and aponeurosis covering its fibres; 3, tendons of the adductor magnus; 2, adductor longus and its thin tendinous cord, which unites it to the preceding and vibrates beneath the finger. The aponeurotic covering, or anterior wall of the canal, is open near *c''*, and exposes to view the artery; near *c'* the saphena nerve and anastomotica magna are seen going out.

some arterioles, bifurcates from two to six centimetres below the crural arch; the *profund femoral* is always external, relative to the *superficial artery*.

In the canal of Hunter (Fig. 38) the *anastomotica*

magna originates, which goes out in front, across the anterior wall of this canal, like the *saphenous nerve*.

The *femoral vein*, on a level with the crural arch, is to the inside of the artery; in descending, it bears more and more in rear. In the canal of Hunter, it is always under the artery, which is, nevertheless, ordinarily covered by a collateral vein of variable volume.

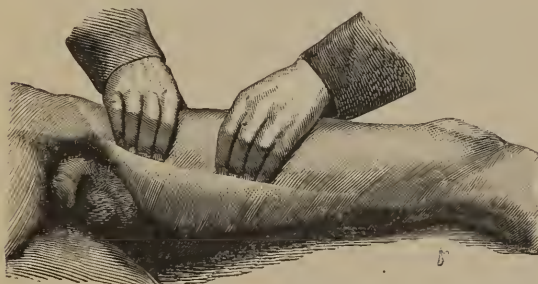
We may ligate the femoral artery at three principal points: 1, *at the base of Scarpa's triangle*, or in the first fourth of the thigh; 2, at the apex of this triangle, that is to say, *above the middle of the thigh*, in its second fourth (called ligation of the middle part); and 3, below the middle, in the *canal of Hunter*, above the ring, or in the third quarter. As to the inferior fourth of the thigh, which one covers when he puts four fingers crosswise immediately above the internal condyle, we never touch it; the artery, having become popliteal, can be discovered with ease at the posterior part only.

Line of operation.—Search for the spines of the pubis with the thumb and the left index-finger;¹

¹ Many pupils, touching the mons veneris with a single finger, and always recognizing a bony base, think themselves at once upon the spine of the pubis, when they are in reality too near the symphysis. It is necessary to separate the thumb and the index-finger about eight centimetres, and carry them to each side of the pubis. On pressing firmly, and causing the fingers to approach each other, we perceive the spines very clearly.

mark well the one on the side to be operated upon. Mark also the anterior superior iliac spinous process, and determine the middle of the crural arch thus limited. From this point draw a straight line, terminating below, *in rear* of the internal condyle,—not to the inside, but *to the rear*.

FIG. 39.



MARCILAND

Ligation of the femoral artery.—The limb is stretched, and turned slightly outwards. The two hands explore the anterior face of the thigh, searching for the great groove formed by the plane of the adductors and the quadriceps femoris, and, being depressed in the depth of the groove, run down it. It will be well also to search for the saphenous vein, if it is easily dilatable.

Be certain that this line coincides with the anterior groove, which, thanks to the muscular reliefs, is sensible to the fingers, and generally to the eye.

§ 1. **In the canal of Hunter.**—The patient is laid upon his back; the thigh first rests on its posterior external face; afterwards the limb is flexed, and the thigh put into abduction.

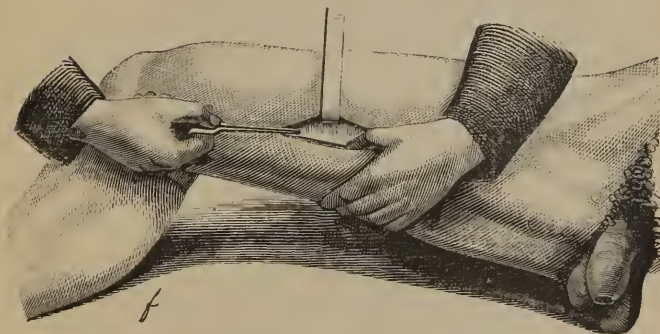
The surgeon places himself to the outer side, and, approaching the limb, lowers his head a little, to see distinctly the internal face of the thigh.

Upon the line indicated, four finger-breadths above the internal condyle, commence or terminate (according to the side) your incision, which is 0^m.08 long. Cut the skin and cellular tissue, avoiding the veins which may present. Cut also the aponeurosis, to expose the *sartorius muscle* (first landmark), which you will recognize by the direction of its fibres.¹ With the grooved director isolate the anterior border of this muscle, and draw it down. Then put the left index-finger into the bottom of the wound, while the right hand, seizing the knee, flexes the limb, and carries the thigh into abduction to *stretch* the adductor muscle. This *indispensable* manœuvre makes the internal border of the adductor magnus very distinct (second landmark), of which a *thin* and very tense part resists and can *vibrate* under the exploring finger. Immediately outward you can perceive the artery, across the anterior depressible wall of the canal of Hunter. Separate

¹ If, forgetting to make the line of operation come out in rear of the internal condyle, and, approaching the member and lowering the head, one incises too far forward, he will soon fall upon the oblique fibres of the vastus internus below and to the outer side. It is necessary to go in rear up to the fibres of the sartorius running obliquely below and to the inside.

the lips of the wound and tear the cellular tissue, which still persists in masking this fibrous wall. Search for the saphenous nerve below, at its orifice of exit; and if you do not see it, by an artificial opening slip the director beneath the aponeurotic covering (Fig. 40). Slip it *close to*, and

FIG. 40.



Ligation of the femoral artery (in the canal of Hunter).—The limb has been flexed, the thigh turned outward, and the thumb of the left hand is upon the tendinous cord. Immediately to the outside, by the orifice of the saphenous nerve, the director is slid beneath the aponeurotic covering.

lengthwise of, the always-stretched tendinous cord, the thigh resting in a state of abduction, and from which your finger all the while has not been taken off.¹ Be certain that the aponeurosis

¹ This tendinous cord is not exactly the internal border of the adductor magnus, but depends rather upon the adductor longus (see Fig. 38, 2). It is bordered inward by the muscular fibres of the adductor magnus, fibres clothed with an

alone is elevated; cut it, and then try to dis-embarrass the artery from the canal, where the veins and nerves are placed in front. Denude with care; the great vein is in rear. A curved artery-needle is indispensable.

§ 2. **Above the middle of the thigh.**—Dorsal decubitus, surgeon to the outside.

Upon the line indicated make an incision of 0^m.08 through the skin and cellular tissue, avoiding the saphenous vein or any of its branches. After having cut the aponeurosis, recognize the fibres of the sartorius by their direction. Look for and isolate the internal border of this muscle, and draw it outward, making traction upon it yourself with the left index-finger, which, plunged into the wound, perceives the artery as it traverses the groove. Place a retractor on each lip of the wound, and, the aponeurotic sheath being

aponeurosis, which may impose upon the *eyes*, and which pupils frequently incise. It is necessary, then, to cut outward from the cord, which vibrates, and very near to, though not to enter into, the vastus internus, a mistake still more frequently committed; say about two millimetres outward.

In being guided by the eye, one is tempted, when he does not see the saphenous nerve, which goes out at various heights, to cut he knows not where; for the vastus internus, the artery, and the adductor are masked by an aponeurotic covering. The finger alone, which perceives the cord, and immediately to the outside the groove of the artery, which cord and groove are very marked only during the abduction of the limb, does not permit one to be deceived.

thus exposed, open it by tearing or cutting on the grooved director. Then open the cellular sheath carefully, in order to leave the vein and nerve in place. Charge it from within outward.¹

§ 3. **At the base of Scarpa's triangle.**—The process which is described for the ligation of the primitive femoral artery permits, with very simple modifications, the ligation at will of the superficial or deep femoral artery.

The patient lies upon his back. The surgeon, placing himself to the outside, determines the middle of the crural arch, and searches for the pulsations of the artery.

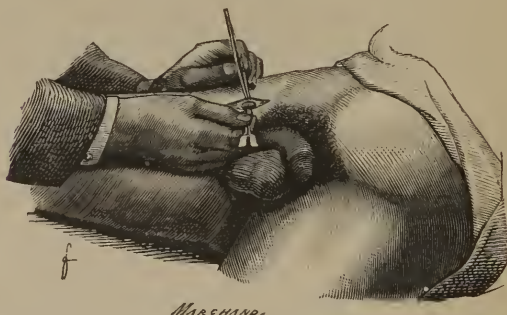
In the middle of the femoral arch² commence or terminate your incision (according to the side), which descends 0^m.06 lower in the direction indicated. Cut delicately the skin and the thickness of the superficial fascia, sparing the ganglia and any large veins you may find. The femoral arch being denuded in the upper part of the

¹ It is especially during this operation that pupils ought to practice denuding the artery, methodically and surgically, with the director and bistoury, as has been said in chap. i., and figured in reference to the radial artery.

² This point is situated to the outside of the vessel sought for, and we make our incision there, to avoid the crural and saphenous veins, which ought not to be seen. Nevertheless, in very muscular subjects, since the psoas pushes the artery inwards, it is proper to incise it about 0^m.01 inside of the middle line of the arch.

wound, put your finger below it to feel the artery and compress it against the bone. Cut the cribriform fascia on the director, with a single incision or more, down to a level with the artery. Look out for the arterioles: ligate them or twist them, if you wish to operate dry. After having once more touched the artery, separate the lips of the wound, denude it carefully and methodically near the femoral arch,¹ attacking the exter-

FIG. 41.



Ligation of the femoral (upper part).—The right hand has engaged the director inward, between the vein and the artery; the left hand, having pinched up the external lip of the sheath, is lowered to permit the director to become engaged.

nal side of the sheath, to avoid all risk of wounding the vein. Charge from within outwards.²

¹ In order to be sure of ligating the primitive femoral, which bifurcates sometimes after passing only 0^m.02 from the arch.

² One need have no fear of impinging upon the nerve, which ought to lie buried in the sheath of the psoas.

For ligation of the superficial or profound femoral artery, the incision does not mount up quite to the crural arch. We will find the artery at first superficial,¹ and then a little deeper at the origin of the profunda.

ARTICLE VI.

LIGATION OF THE EXTERNAL ILIAC.

The external iliac artery, with its accompanying veins situated to the inside and rear, is attached by a thin aponeurotic fold to the internal border of the psoas, and contributes to form the contour of the superior strait of the pelvis. The vessels of the cord, the ganglia, and the lymphatic vessels cover it.

After having evacuated the alimentary canal to avoid a tympanitic condition of the abdomen, we lay the patient upon his back, the shoulders and head being elevated by pillows, to relax the abdominal walls.

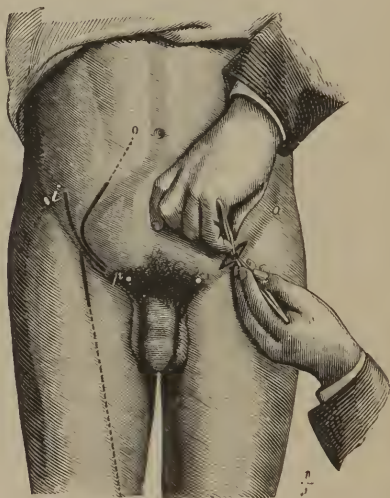
The surgeon will search for the crural arch, its extremities, its middle, and the pulsations of the primitive femoral artery.

At some millimetres above the femoral arch, commencing (or finishing) at 0^m.03 from the spine

¹ When bifurcation is anticipated, the two arteries rest at first upon the same plane, the superficial to the inside, the profound outside, and it is only at the ordinary place (0^m.06 from the arch) that it becomes profound.

of the pubis, make an incision of 0^m.07 parallel to the arch. Cut and tie the subcutaneous ab-

FIG. 42.



Ligation of the iliac arteries (*traces of the incisions*).—**Denudation of the epigastric artery.**—*p*, pubic spine; *i*, anterior superior iliac spine; *o*, point situated 0^m.03 to the outside of the umbilicus; *p i*, incision of Astley Cooper, Roux, etc., to ligate the internal iliac or the primitive iliac. This incision, prolonged not quite so high towards the iliac spine *i*, is very convenient for ligating the epigastric, or the internal iliac (Bogros, etc.); *p o*, incision indispensable for the easy ligation of the primitive and internal iliacs (M. Duval). This is a combination of the incisions of A. Cooper and Abernethy.

dominal vessels. Incise and cut at a stroke the aponeurosis of the obliquus abdominis, either by means of a bistoury or by blunt-pointed scissors.¹

¹ The distance is perhaps double in the external part of the incision, which in this case is not exactly parallel to the arch.

With the point of the director search for the inferior border of the internal oblique, and draw it above, destroying its adhesions to the crural arch and lifting the cord up with it. Put the finger into the wound and the inguinal ring, and try to feel the artery through the transverse fascia. Tear this fascia only to the outside of the ring, or cut it, after having pinched it up.¹ Then put the finger again into the incision, and you will certainly perceive the vessels. Put in a very large retractor, with which you lift up the superior lip of the wound, along with the peritoneum, and approach the artery from the outer side: you have to avoid the circumflex vessels and some ganglia, to tear a thin aponeurosis, and finally the cellular sheath. Charge it from within outward with a curved artery-needle, while the finger separates the vein, and ligate it at 0^m.03 above the femoral arch.²

¹ Although the peritoneum does not descend so low as to be wounded at this level, it is necessary to tear the *fascia transversalis* carefully, always in the direction of the artery, of which it is sufficient to discover the external side.

² In order to ligate it at a sufficient distance from the epigastric and the circumflex, which, because of the ligature, will bring the blood into the inferior extremity of the artery ligated.

ARTICLE VII.

EXCEPTIONAL LIGATIONS.

I shall describe here the ligations of the *primitive and internal iliacs*, the *gluteal*, the *ischiatric*, and the *internal pudic*. I have called them exceptional, to let pupils know that the occasion and possibility of practicing them are exceedingly rare. They demand an ability which cannot be reasonably hoped for from all practitioners.

§ 1. **Ligation of the primitive and internal iliacs.**—One may divine, from Fig. 42, the track and depth of these vessels; their veins are always to the inside and behind. To discover them it is necessary to loosen the peritoneum which covers the iliac fossa, and, the peritoneum being pushed inward, to draw away the genital vessels and ureter: the rest is very easy.

The commencement of the operation ought to be conducted with prudence and judgment: it is necessary at first to incise the abdominal walls and to commence loosening the peritoneum. The object to be attained demands long fingers in the surgeon who explores, isolates, and ligates the vessel, and in the assistant who separates and protects the peritoneum.

An incision parallel to the femoral arch, such as is employed to exhibit the external iliac, would here be entirely insufficient. It is necessary to incise the abdominal wall in the direction of the vessels, but to

the outside of them; then we must go outward, and separate the peritoneum from the iliac fossa.

The best incision is that indicated by M. Marcellin Duval: it is a combination of the processes of Cooper and Abernethy.

The patient has been prepared and placed as if for the ligation of the external iliac.

For the right side: at 0^m.03 to the outside of the spine of the pubis, above and near to the femoral arch, commence an incision of 0^m.12, which may be parallel to the arch in its first third; its curve follows in the arc of a circle (middle third), to mount, finally, perpendicularly to the arch (last third), towards a point situated 0^m.03 to the outside of the umbilicus (Fig. 42, *p o*). For the left side the same incision should be made in an opposite direction. Cut likewise the aponeurosis of the external oblique, after it has been revealed by section of the adipose tissue and ligation of the subcutaneous abdominal vessels. Strip the inferior border of the internal oblique from the crural arch, and cut with a probe-pointed bistoury the fibres of this muscle in the ascending part of the incision, either directly by aid of the forceps, or upon a large blunt director, or, what is better, upon the end of the finger insinuated gradually from below to above between the obliquus and the transversalis. Incise this and the fascia transversalis in turn; search for the inguinal ring, and to the outside of it pinch

up the fascia, make a nick in it, and tear it above the arch.¹ Then, with the end of the finger carried from below upward, gradually separate the peritoneum, and in like proportion cut the transversalis muscle and its fascia in the ascending portion of the wound. Bring the finger towards the arch, and touch the artery. Then separate the peritoneum of the iliac fossa with the fingers, without the assistance of any instrument. Take care to go gently, following the external iliac artery, which will guide you, and, scratching with the nails the iliac aponeurosis, to crowd back along with the peritoneum all the cellular tissue, and in this cellular tissue the genital vessels, and more deeply the ureter. Finally, when, having arrived at the vessel to be ligated, you wish to isolate it, let your assistant bury two fingers very deeply, and draw the peritoneum upward and inward, while, continuing with the finger and a long blunt instrument, forceps or director, you isolate your artery. Pass the ligature with a curved instrument from within outward, the finger in the mean while protecting the veins.²

¹ In tearing outward from the ring, the epigastric artery is spared; it is only necessary not to touch the circumflex vessels; what we should do, if we fear lest at this level we might injure the peritoneum, is to go very near the arch, and immediately in rear of it. This, however, would not be a grave accident.

² The internal iliac artery ought to be ligated 0^m.02 from its origin, and, consequently, very near its first collateral.

§ 2. **Ligation of the epigastric.**—This artery originates at the termination of the external iliac: it first runs inward, then upward. In its ascending track it is found nearly a finger-breadth within the middle of the crural arch. We know its connections with the components of the cord in man, and with the round ligament in woman. It is situated in the subperitoneal tissue, and, consequently, under the *fascia transversalis*. Two veins, which are easy to isolate, accompany it; but near to their confluence into the iliac vein these veins receive, in man, many veinlets from the cord (funicular veins), which almost completely mask the epigastric artery at its origin. For this reason, and also to avoid enlarging the internal inguinal orifice and opening the way to a hernia, it is perhaps(?) better, in man especially, to seek the artery above the cord than below it, even at the origin of the vessel.

The patient lies on his back.

The surgeon explores the region, causes the subcutaneous abdominal veins to show themselves if he can, etc., and looks for the pulsations of the primitive femoral artery, the crural arch, its extremities and middle.

At a finger-breadth above the arch, and parallel to it, make an incision in the skin of 0^m.05, the middle of which corresponds to the artery sought for,—that is to say, at a finger-breadth within the middle of the arch.

Then cut the cellular tissue; separate, or cut and ligate, the cutaneous vessels. Coming down

to the aponeurosis of the external oblique muscle, incise it carefully, holding the bistoury firmly.¹ Afterwards, with the point of the director, penetrate between the united fasciæ of the internal oblique and transversalis muscles, above the cord, which is pushed downward.² You will soon feel the resistance of the fascia transversalis, and can see its white color and fibrous aspect; tear it with two forceps, and, putting the finger into the wound, search for the artery. Upon the cadaver it generally forms an almost vertical cord, which is perceptible to the finger.

Denude this with forceps (Fig. 42), by means of which you at first tear a yellowish fatty tissue, and then the cellular sheath, in order that the artery-needle may be easily engaged.

§ 3. **Ligation of the gluteal artery.**—A glance at Fig. 43 shows how the three arteries

¹ If one wishes to ligate the artery at its origin, he will incise nearer the arch, and elevate the inferior border of the oblique and transverse muscles and the cord which is comprised within them. The execution of this is even easier, and the wounding of the peritoneum is next to impossible; but the inguinal ring is forcibly enlarged.

² The tearing ought to be of the slightest possible extent, at the risk of being obliged to enlarge it if the artery be not found at once. It is necessary at first to tear inside, so as to try and spare the fibres which encircle the inguinal ring internally, for if one tears this ring the proceeding has no advantage over that which consists in ligating beneath the cord.

run which may be ligated across the gluteus magnus.

FIG. 43.



Arteries traversing the sciatic notch above and below the pyramidalis muscle.—1, posterior superior iliac spine; 2, posterior inferior iliac spine; 3, gluteal artery (its deep branch), another branch which descends towards No. 4 has been turned up; 4, pyramidalis muscle; 5, great sciatic nerve; 6, small sciatic nerve; 7, internal pudic artery; between 7 and 8, pudic nerve; 8, ischiatic artery, its great descending branch ought to cross the pudic just below No. 7, but it has been shown to the inside to make the figure clearer.

It is possible on the living subject, by aid of certain easily-found landmarks, to determine the point corresponding to the egress of each artery of the buttock. These landmarks are: 1st, the posterior superior iliac spine; 2d, the posterior superior angle, or summit of the great trochanter; 3d, the sacral crest or median line.

It is at 0^m.08 from the median line that the arteries

emerge; the gluteal, above the pyriformis muscle, lies in a straight line drawn from the posterior superior iliac spinous process to the great trochanter; the ischiatic and pudic lie upon a line parallel to the preceding, but lower than the width of the pyriformis muscle, that is to say, about 0^m.03. These ilio-trochanteric lines are parallel to the fibres of the gluteal muscle. To discover the gluteal arteries, we cut upon these lines; but, if we do not wish to be greatly troubled by the tension of the lips of the wound, it will be necessary to detach a little the sacral insertions of the inferior fibres of the gluteal muscle, and to curve the cutaneous incision a little in the beginning.

The patient will be laid on the edge of the bed, upon his belly; the extremity of the foot outside, to relax the gluteus magnus muscle.

The surgeon, placing himself on the side on which he is going to operate, searches for the posterior superior iliac spinous process and the summit of the great trochanter; he will station himself *near the side* of the patient.

At 0^m.03 below the posterior superior iliac spine, commence an incision, which shall first go upward and outward to the level of this spine, then curve around to a right angle to bear outwards and downwards towards the great trochanter, to the extent of about 0^m.08.¹ The

¹ The total length of the incision is about 0^m.12. The last part is the principal and much the longer portion: it follows

gluteus magnus being exposed, open one of its interstices with the bistoury, and destroy the sacro-ilio-ligamentous insertions of the inferior fibres, which will then fall easily below. Then put the finger into the wound and search for the great depressible notch, and the bony *arch*, which limits it above. All this can be perceived beneath the subgluteal aponeurosis, which it is now necessary to tear along and above the arch.¹ This done, carry the left index-finger deeply between the arch and the pyriformis muscle, within towards the sacrum, to perceive, despite the ligamentous fibres remaining, the angle formed by the sacro-iliac articulation and the small posterior inferior iliac spine. Following then below the arch from within outwards, with the pulp of the finger, you will encounter (at about 0^m.03) a vasculo-nervous cord, at the middle of which you will, by the touch, perceive the artery.² The artery being found, proceed to isolate it, and

the ilio-trochanteric line and the direction of the fibres of the gluteus maximus: the first part has for its object the permitting of the destruction of the insertions of the sacro-iliac ligaments of the muscular fascia which goes to form the inferior lip of the wound, and which is not easily lowered without this loosening.

¹ This aponeurosis, thin in its external part, is only a continuation of the external border of the great sacro-sciatic ligament; as we approach the sacrum it becomes more and more resistant.

² It is principally to search for the vasculo-nervous bundle and to diagnose the artery that one should place himself near

place the ligature beneath the arch, almost in the pelvis.¹

§ 4. Ischiatic and internal pudic arteries.

—The patient will be placed as if for the ligation of the gluteal; the surgeon will make the researches which have been already mentioned; but, the incision once made, he will place himself *near the thigh* of the patient.

An incision like that for the gluteal, but situated 0^m.03 lower, will conduct to the subgluteal aponeurosis, and permit the finger easily to perceive the *ischiatric spine*, the small sacro-sciatic ligament attaching itself here, and higher the inferior depressible part of the great notch. At this level, along and beneath the pyriformis muscle, the aponeurosis will be torn, and the finger, deeply buried, will search for the arteries. We will stop first on the summit of the ischiatic spine (landmark), where perhaps there will be perceived a small nervous cord, the pudic nerve: if we go some millimetres *inward*, on the superior border of the ligament,² we can recognize

the side of the patient, in order to allow his left hand to act with freedom.

¹ It is not easy to spare the great veins accompanying this artery: why not embrace them in the ligature? It is necessary to place the thread deep, to be sure of ligating *the trunk* of the artery, and not one of its two principal branches.

² The relations which I indicate cannot serve as a guide, if we search for the vessels beneath the ischiatic spine and its

the *ischiatric artery* on compressing it lightly; and if we go some millimetres *outward*, on the superior border of the spine, the *pudic artery* will be recognized. Farther on to the outside, we will find the small and great sciatic nerves, which together form a voluminous mass.

ligament, for the ischiatic artery scarcely emerges from the pelvis before it divides, and its principal branch almost immediately becomes posterior, and then, relative to the pudic, external.

THE END.

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